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POWER PLANT OF THE HUYLER CANDY FACTORY

AN IDEAL PLANT EQUIPPED WITH "IDEAL" ENGINES

ANYBODY who is fond of sweets will tell you what Huyler makes, but few know where Huyler is. Of course they know where the nearest store is to be found, but that is not the real Huyler; he is only where the good things are made, in the heart of the factory.

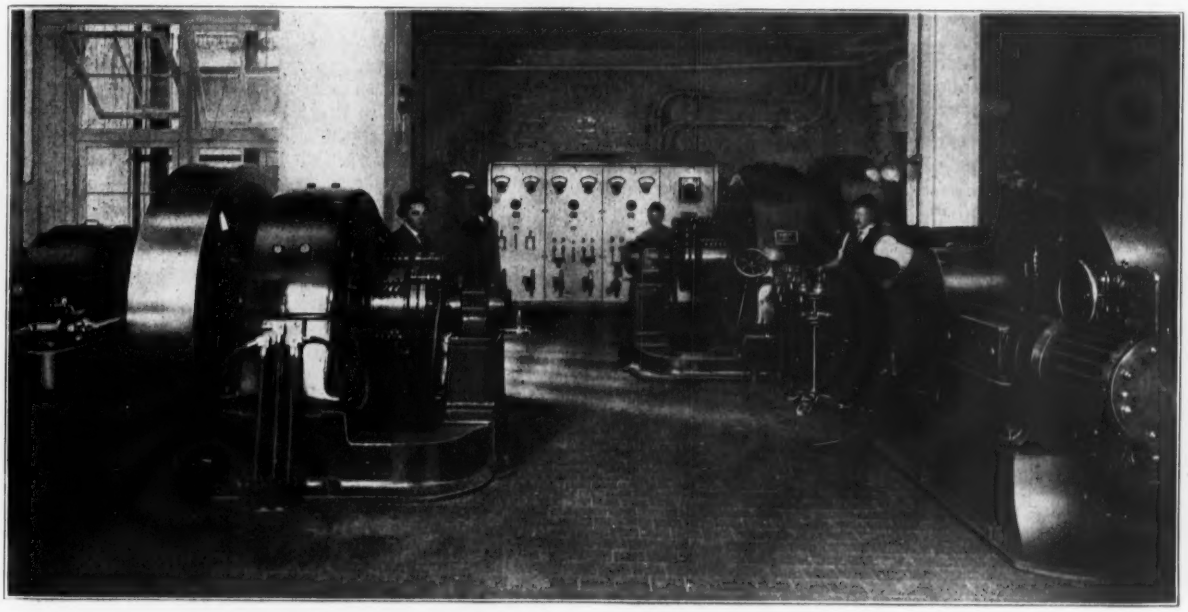


FIG. 1—THE ENGINE ROOM IN "HUYLER'S"

Did you ever burn your fingers with a dish of hot molasses? Then you know just how hot such things are, and you will realize that a lot of heat is needed in making a lot of candy. That means a big steam plant, and for the power to make the pulled varieties, and to mix the "batter" and to furnish the light, a lot of heat units are also required. Fortunately, by a combination of the 2 things, it is possible to make the same heat units work overtime and thus effect a good saving over the use of steam for the heating and central station current for the lights and motors, and because they realized this fact, the managers of the Huyler plant decided to change from the Edison current and to make their own from the steam which was used in making the candy. Then came careful investigation of the best arrangement of plant and the best machinery for the purpose, for it is the policy of Huyler to get only the best in materials, and to make only the best in products.

The Plant

The plant is located at the corner of 18th St. and Irving Place in New York City, and is as shown in Fig. 2. The machinery throughout the plant is of the latest and most approved type, labor saving apparatus being used wherever it can be placed to advantage, and all equipment chosen with respect to cleanliness and

the elimination of personal handling of the ingredients or the product. The building is entirely fireproof with the workroom supplied with every known sanitary appliance, wood being eliminated, and the floors and walls of glazed tile.

Walls of the engine room are finished in white glazed tile and the floor in red French tile. The switchboard is of white marble with black instruments and

FIG. 2—THE HUYLER FACTORY IN NEW YORK

the border of copper moulding, finished by copper grill work at the ends. This gives an idea of the completeness and elegance of the plant, and all details are carried out in the same spirit.

Boiler Room

Power originates of course in the boiler room, where 5 boilers are installed, all of Babcock and Wil-

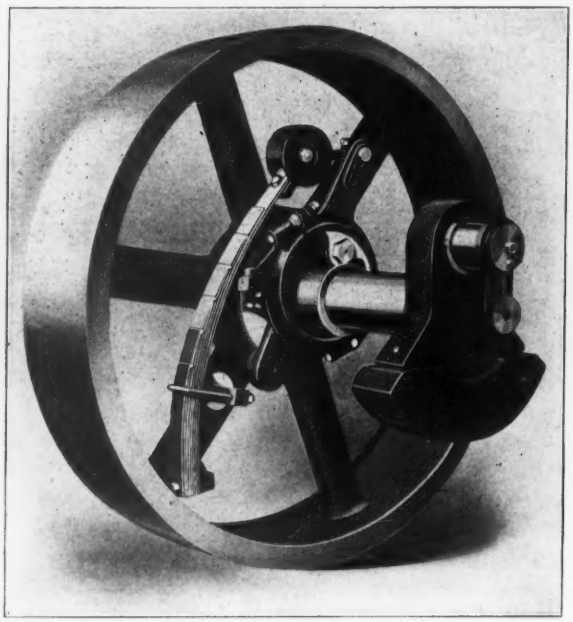


FIG. 3—ARMSTRONG GOVERNOR OF THE IDEAL ENGINE

cox make. Three are of 200 hp. each, 1 is 150 hp. and 1 is 100 hp.; all carry 125 lb. steam pressure. No. 1 buckwheat coal is used and water taken from the city mains. The coal required in a day of 24 hr. is 40,800 lb. and the ash removed is 6,700 lb., or about 14 per cent. The water used per day is, for power and manufacturing purposes, 8,800 cu. ft.

Pumps and Their Uses

Hydraulic elevators, dumb waiters, house supply, boiler feeding and refrigerating system require a large

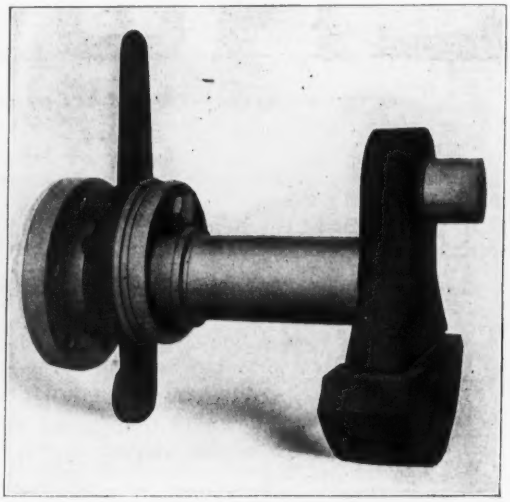


FIG. 4—CRANK END OF SHAFT CARRYING ECCENTRIC AND HAVING CRANK SOLID WITH THE SHAFT

pump equipment. There are also 14 other pumps for handling material in the process of manufacture, these being distributed about the plant as needed. For the freight elevators, of which there are 2, and the 2 dumb waiters, there are 2 compound direct acting duplex pumps giving high pressure when needed. For the house service are 2 compound pumps, and 2 others for the boiler feeding; in the refrigerating system are 2 ammonia pumps and 3 duplex brine pumps.

Both compression and absorption machines are employed in this part of the work, thus giving wide flexibility to meet the varying demands as to temperature requirements.

In the Engine Room

Here are found 2 William Wright Corliss engines, 1 of 150 hp. and the other of 125 hp. These are belted to line shaft and furnish power to portions of the building. For generating electric current there are 3 Ideal engines made by A. L. Ide & Sons of Springfield, Ill., 1 being a tandem compound driving a 150-kw. direct-current generator which gives current at either 125 or 250 volts, made by the General Electric Co.; another is a tandem compound driving a 100-kw. generator similar to the above, and the third is a simple engine driving a 50-kw. generator.

Each machine has a panel on the switchboard, and a fourth panel is provided for distribution.

All 3 engines are provided with Ideal steam separators and Graphoil mechanical force feed lubricators, which add to each drop of oil on its way to the cylinder a certain amount of graphite to aid in the lubrication of valves and piston.

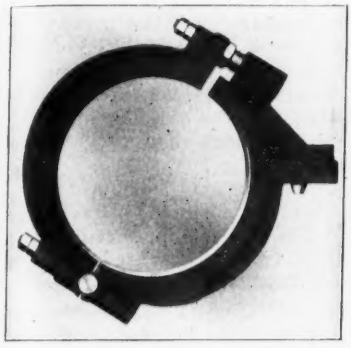
While the load on the plant is not fluctuating, it varies from day to day and from hour to hour; the engine sizes were therefore chosen so that the engines in use could always have a load near to the rated

capacity, and the plant thus be run at good economy. Load carried by the generators is as follows: 27 motors divided into 1 1-hp., 1 2-hp., 8 3-hp., 1 5-hp., 1 7-hp., 2 7.5-hp., 6 10-hp., 4 15-hp., 1 25-hp., 1 40-hp., 1 50-hp. The lighting load consists of 75 arc lamps and 1,000 incandescents. Motors are used for driving machines or parts of machines as needed except the 2 largest which are for reserve in case of the Wright engines being out of commission for driving the shafting.

Ideal Engines

These have a number of novel features which are well worth considering in detail. They are of the side crank type with all reciprocating parts enclosed, and the frame designed to have beauty and graceful lines as well as strength. The engines are therefore attractive because they are always clean and are of pleasing appearance. Access to the crosshead is from a door in the side of the frame, and to the crank by the removal of the upper part of the crank casing. By 3 bosses on the frame and a gage to be screwed into the crank counterweight, the crank can readily be tested for square with the frame at any time.

Main bearings are large and of 2 parts with removable shell lined with special babbit metal. This avoids pressure at the joints of the bearing so that oil is always drawn between the bearing surfaces, rather than wiped off. A housing around the shaft on the eccentric side of the bearing prevents the escape of oil.



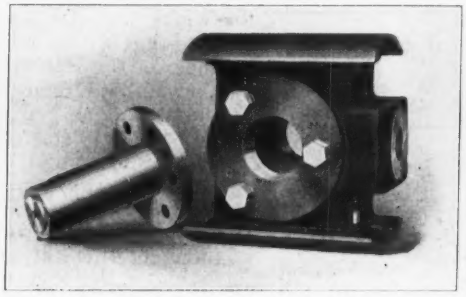


FIG. 5.—ECCENTRIC STRAP, CROSSHEAD AND FLANGED WRISTPIN OF IDEAL ENGINE

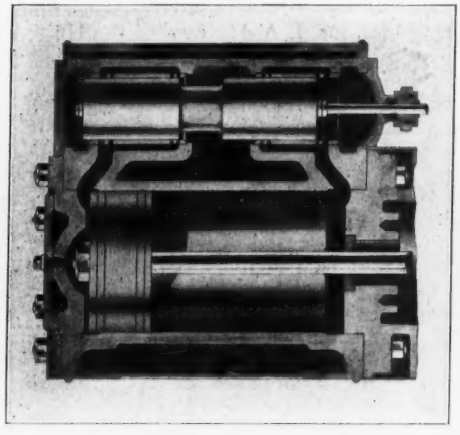


FIG. 6—SECTION OF "IDEAL" CYLINDER AND VALVE CHEST, SHOWING PISTON VALVE AND BUSHING SEATS

Flywheel and Shaft

The flywheel is solid, having the shaft sections connected to it by means of recessed flanges which fit into the hub. It is not necessary therefore to use a split pulley or to force the flywheel on the shaft. When the armature of a direct connected unit is to be pressed on the shaft, only the generator shaft extension is sent to the generator makers, the rest going to the plant direct from the engine works. The armature can be taken out of the unit for truing the commutator or repairing the windings without disturbing the rest of the unit. There is no chance for trouble with a loose driving key, and not the least advantage, the crank is made in one piece with the crank end of the shaft giving strength, simplicity and rigidity.

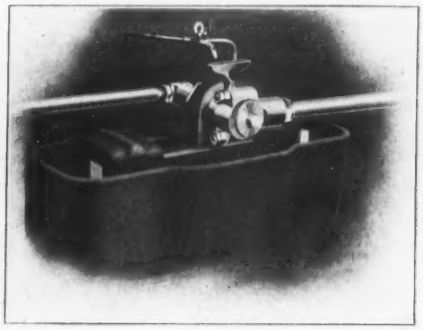


FIG. 7—VALVE SLIDE CONNECTING VALVE ROD TO ECCENTRIC ROD

Valve Mechanism

Mechanism for driving the valve and regulating the admission of steam is simple and powerful. The eccentric is made in 2 parts and bolted together; it is suspended from a bracket pin attached to the shaft, and carries an arm to which a link from the Armstrong governor is attached. A leaf spring resists the contrifugal force of the weight of the governor, which is mounted on the end of the spring so that there is no bearing to cause trouble from friction; to change the regulation of the governor it is only necessary to move the pin in the eccentric arm toward or away from the eccentric, and to change the speed, the tension of the spring is changed. The adjustments are therefore the simplest possible.

Two parts of the eccentric strap are lined with babbit metal which is so turned that it is the arc of a

FIG. 8—IDEAL TANDEM COMPOUND ENGINE DRIVING GENERAL ELECTRIC GENERATOR

circle; lateral motion and noise are thus eliminated. A fine screw adjustment of the position of the 2 parts of the strap makes the use of liners unnecessary, and ensures perfect fit to the eccentric.

To connect the eccentric rod to the valve rod a slide is used, shown in Fig. 7, running in a reservoir of oil, and with so large bearing surfaces and so little wear that adjustment is rarely required.

Piston valves have been adopted as they are simple in design and construction, light in weight and perfect in balance. For renewal when that becomes necessary, a portable boring bar is provided which can be readily attached to the valve chest, and a reamer which leaves the seat bushings just the size of the new valve. Reboring and installation of a new valve are the work of only a few hours.

In the crosshead, a box form is adopted reinforced by ribs so as to give great strength; it has shoes of

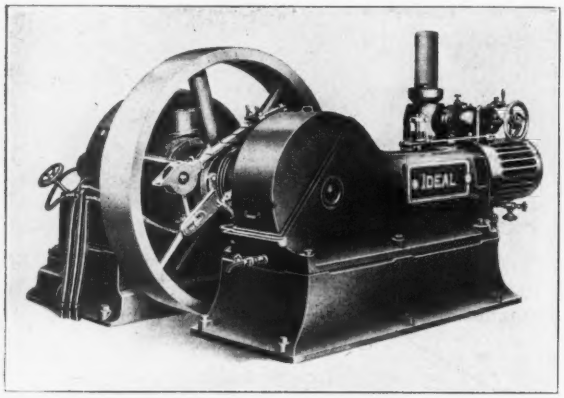


FIG. 9—IDEAL SIMPLE ENGINE AND ITS GENERATOR

bronze turned to the arc of a circle, hence self adjusting; the wear is slight so that adjustment is infrequent, and the lower shoe only needs taking up. The wristpin is made with a flange for bolting it to the crosshead, and is cylindrical in form so that it can be turned into 9 different positions to present new bearing surfaces.

Oiling is from a central reservoir in the frame under the crank. The crank sprays the oil over crosshead and crank case whence it runs to pockets from which it is delivered by gravity and centrifugal force to the main bearings, to the crankpin and to other parts of the engine. This gives abundant and continuous oiling.

The name Ideal well fits the engine and was adopted by the makers nearly 40 yr. ago as a watchword expressing the policy to be followed and the standard to be maintained in manufacturing of its engines.

OCCLUDED GASES IN COAL is the title of Bulletin 32 issued by the Engineering Experiment Station of the University of Illinois. This is written by S. W. Parr and Perry Baker, who have conducted experiments on the behavior of coal when exposed to the air and shows how rapidly coal takes up oxygen from the air and what the effects are of weathering and of spontaneous combustion. Copies of the bulletin may be had on application to W. F. M. Goss, director of the Engineering Experiment Station, Urbana, Ill.

AREA OF THE UPTAKE in a vertical boiler should be about 1-12 to 1-14 of the area of the fire grate.

NOTEWORTHY ENGINE PERFORMANCE

ON Jan. 4 and 5 an official test was made of the new high duty pumping engine recently installed in the North Point pumping station of the city of Milwaukee. This engine is of the vertical triple-expansion, crank and flywheel type, with a capacity of 12,000,000 gal. per 24 hr. It operates against a head of 275 ft. and receives steam at 125 lb. pressure. The guarantee calls for a duty of 165,000,000 ft. lb.

This pumping engine was built by Allis-Chalmers Co. and is the fifth which has been installed at the North Point station by the same company. A duplicate of the unit just tested is now being built. The pumping engine which the company installed in 1892 became noted for the high duty of over 154,000,000 ft. lb., which was the highest obtained up to that time. In speaking of this unit, Thomas McMillan, the chief engineer of the station, stated that the cylinder heads had never been removed in the more than 18 yr. in which the engine had been in service.

The test was started at 9:30 Tuesday morning and continued until 9:30 Wednesday morning. Chas. J. Pietsch, city engineer of Milwaukee, supervised the test for the city and Wm. H. Getz represented Allis-Chalmers Co. Thomas McMillan, who has been chief engineer of the station for nearly 40 yr., personally looked after the operation of the engine.

The test of the pumping engine proved highly satisfactory, both to the city and to the manufacturers. During the continuous run of 24 hr. the unit developed an average duty of 175,400,000 ft. lb. per 1,000 lb. of steam, which is 10,400,000 ft. lb. more than guaranteed, and the pumping unit showed the highest duty of any in the station.

SHOULD COAL COST MORE?

IN AN address before the National Civic Federation, speaking of the accidents in coal mines and the resulting loss, Dr. J. A. Holmes, of the United States Geological Survey, says that a large part of this waste is due to the ruinous competition between mine operators, which forces the smaller operator out of business and the larger operator to work under such conditions that only the best of the coal is taken out, and that the methods of mining are not entirely safe.

Dr. Holmes estimates the yearly waste of coal that cannot be profitably mined at present prices as 250,000,000 tons, a large part of which can never be recovered because it is buried by cave-ins. He estimates also a yearly loss of life of 8,000 to 10,000 men from explosions, cave-ins, and various casualties. As remedies for these conditions he proposes first the training of men at the mines as to the best methods of using explosives, handling of gases and dust, timbering, fighting mine fires and methods of rescue work. The development of better and more uniform mining laws and regulations based upon data and experience and determined co-operation between miners and mine operators and state inspectors in enforcement of these rules are also needed.

As another essential Dr. Holmes would have the ruinous competition system now in vogue in coal mining changed and the price paid for coal at the mines fixed at a figure to permit safe and efficient mining which will avoid the loss of life and waste of natural resources.

AREA OF STEAM PORTS should be such that the velocity of steam flow does not exceed 100 ft. per second; 80 ft. per second is ordinary practice.

THE FUEL ECONOMIZER

CALCULATION OF SIZE FOR A POWER PLANT

By Carl S. Dow

THE size of a fuel economizer is usually designated by the number of square feet of heating surface it contains, not by the length, width, or height. The area of heating surface depends upon the effect to be produced and this is of course limited by the operating conditions. In purchasing an economizer, it may be desired to heat a given weight of water to a certain temperature for washing, dyeing, heating, etc.; or in a power plant the object may be to save as much coal as possible while maintaining a given power output, or to add to the steaming capacity.

Ordinarily, the result sought is the reduction in cost of a horsepower, the saving being brought about both from the heating of feed water by utilizing otherwise wasted heat and the saving in labor expense when conditions are such that the economizer makes it possible to reduce the fire room labor.

Determining Factors

To determine the size of an economizer, the designer must know all the working conditions, in fact, the more he knows about the power plant the better he can select a size which shall result in the greatest saving. It is readily seen that with a steady load the economizer should have heating surface enough to utilize all the available heat units and heat all the boiler feed water to as near boiling point, for the pressure carried, as possibe. This means that the problem is not as easy as it seems for there are 3 variables: The available heat units in the gas, the weight of feed water, and the temperature limits of the feed water.

With fluctuating load, both volume and temperature of chimney gas vary from hour to hour, therefore a compromise must be made, for the economizer cannot be "just right" for all conditions.

With varying load and a large plant, the economizer is more effective and more flexible, if the economizer surface is divided up into several units, so that those which are in operation can be run at most economical load.

Fundamentally, the size of an economizer is found by dividing the available heat units by the amount of heat transmitted per square foot of surface; but the available heat is dependent upon the temperature to which the gas is reduced which in turn depends upon the size of the economizer. Again, the amount of heat transferred per square foot of surface depends upon the temperatures and upon the rapidity of flow of hot gas.

An Illustrative Case

Let us assume that a manufacturing plant or mill requires 3,000 boiler horsepower at a reasonably constant load. To save fuel an economizer is to be installed, and yet with the economizer in operation, the boilers and economizer are to furnish 3,000 horsepower. Let us also assume the following:

Steam pressure (gage)	140
Temperature of flue gas (deg. F.)	600
Gas to be cooled to (deg. F.)	420
Specific heat of flue gas	0.24
Air supplied per pound of coal (lb.)	24
Coal required per boiler horsepower per hour (lb.)	4
Temperature of water entering economizer (deg.)	200

Heat Available

Total coal burned per hour without an economizer would be $3{,}000 \times 4 = 12{,}000$ lb. or nearly 5.36 tons. With 12,000 lb. of coal burned there would be $12{,}000 \times 25 = 300{,}000$ lb. of waste gas, for 1 lb. of coal unites with 24 lb., assumed, of air making 25 lb. of gas. The specific heat of the waste gas is usually from 0.20 to 0.25, 0.24 being often used. The specific heat may be found by analyzing the gas and multiplying each constituent by its specific heat, but as all the products of combustion have a specific heat nearly like that of air,

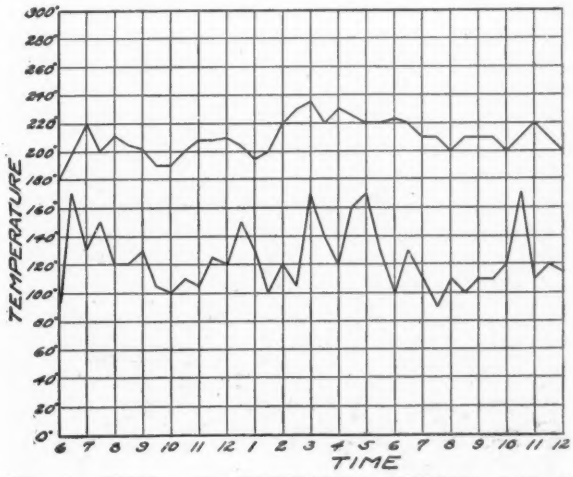


FIG. 1.—RECORD OF TEMPERATURE INCREASE DUE TO ECONOMIZER

Lower curve entering feed water; average 124 deg. Upper curve water leaving economizer; average, 211 deg. Note equalizing effect of economizer

an analysis is not necessary except for very accurate work, in fact, 0.23 or 0.24 is plenty good enough.

Gases and Their Specific Heats

Air	0.237
Oxygen	0.217
Nitrogen	0.24
Carbon dioxide	0.217
Carbon monoxide	0.248

It should be remembered that a large part of the waste gas is nitrogen.

The available B. t. u. are found as follows: $300{,}000 \times 0.24 = 72{,}000$ B. t. u. = the available heat for every degree the gas is cooled. Since the gas is cooled $600 - 420 = 180$ deg., the total available heat will be $72{,}000 \times 180 = 12{,}960{,}000$ B. t. u. Of course, all this heat will not be absorbed by the water; some will be lost by radiation, and some by inleakage of air through the enclosing walls and through the holes through which the scraper chains pass. Heat is lost by inleakage somewhat as follows: The air that leaks in must be heated by the gas in the economizer to the temperature of the mixture of air and gas, taking from the gas heat which should go to the water. Probably about 0.75 of the available heat entering the economizer is transmitted to the water, or in this case:

$$12{,}960{,}000 \times 0.75 = 9{,}720{,}000 \text{ B. t. u.}$$

Division of Power Between Boiler and Economizer

Since 1 boiler horsepower is equivalent to 33,305 B. t. u. the available heat will be equal to $9{,}720{,}000 \div 33{,}$-

305 = 292 horsepower. But only 3,000 horsepower is necessary, therefore the boiler horsepower plus the economizer horsepower is 3,292 ÷ 3,000 = 109.7 per cent of what is needed. To get 3,000 horsepower with the economizer in operation, it will be necessary to cut out some boilers, so that the boiler horsepower will be but 2,735, for 3,000 ÷ 109.7 = 2,735.

Then the coal used per hour would be only 2,735 × 4 = 10,940 lb., and the gas would weigh 10,940 × 25 = 273,500 lb., which with a specific heat of 0.24 and a temperature drop of 180 deg. would result in 273,500 × 0.24 × 180 = 11,815,200 B. t. u. of which 75 per cent or 8,861,400 would probably pass to the water. If all these heat units should go to the water, the performance of the economizer would be equivalent to 8,861,400 ÷ 33,305 = 266 horsepower, and 2,735 ÷ 266 = 3,001. The

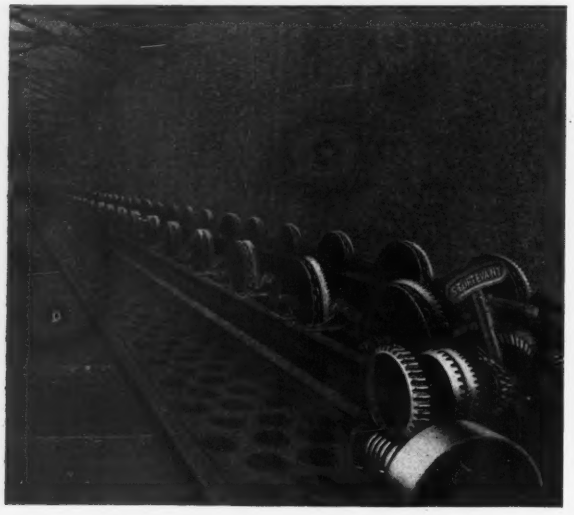


FIG. 2.—ARRANGEMENT OF 2 STURTEVANT ECONOMIZERS; 80 SECTIONS, 10 PIPES EACH

problem now is the determination of economizer heating surface that will transmit 8,861,400 B. t. u. per hour under the conditions assumed.

Heating Surface

For this transmission the area of economizer heating surface depends upon the temperature conditions in the economizer, the factors being the mean temperature difference, and the rate of flow of gas over the surface, for it is evident that the greater the difference in temperature of the mediums on either side of the metal, the faster the heat will flow; also the greater the velocity of hot gas over the surface the greater the transmission per square foot in a given time.

We know that, if the gas enters the economizer at 600 and leaves it at 420 deg. the mean temperature on the hot side will be 600 + 420 ÷ 2 = 510 deg. but what is the mean temperature of the water? The boiler horsepower is 2,735 and as one horsepower is the evaporation of 32.5 lb. of water per hour from 200 deg. into steam at 140 lb. gage, the water evaporated will be 2,735 × 32.5 = 88,887 lb. The factor 32.5 is found by dividing 34.5 (the evaporation from and at 212 deg.) by the factor of evaporation corresponding to 200 deg. and 140 lb. gage.

Since 88,887 lb. of water enter at 200 deg. and absorb 8,861,400 B. t. u. its temperature will be raised 8,861,400 ÷ 88,887 = 99 deg. and will therefore leave at 299 deg., the mean temperature being 249.5 deg.

The mean temperature difference is the difference of the 2 mean temperatures, or 510 — 249.5 = 260.5 deg.

Rate of Heat Flow

The rate at which heat flows to the water in an economizer is usually expressed as a given number of heat units per square foot per degree difference in temperature. The factors vary according to the mean gas temperature, difference in velocity of gas not being allowed for, probably because the velocity is fairly constant under usual power plant conditions. It has been

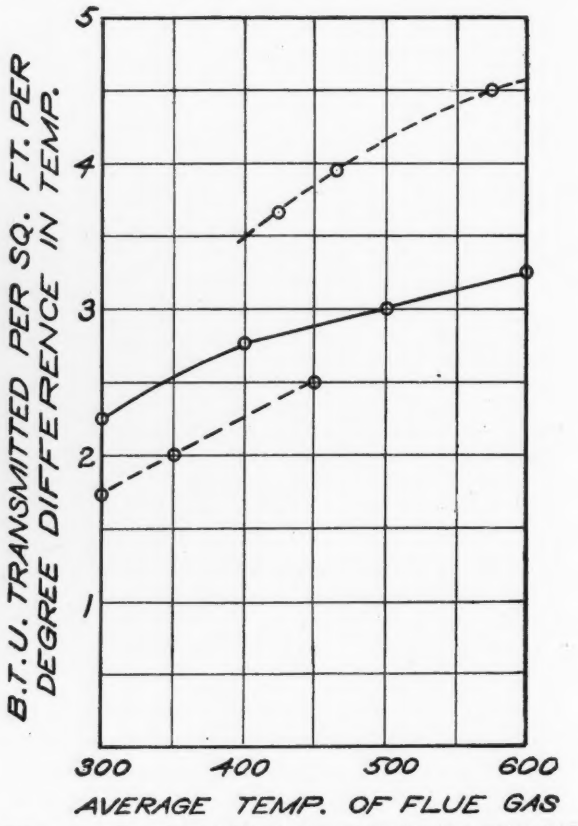


FIG. 3.—RATE OF TRANSMISSION OF HEAT AND FLUE GAS TEMPERATURE

determined by experiment that with the velocity usually found in power plants, these factors are sufficiently accurate for most calculations:

Heat Transmission in Economizers

Mean Gas Temp. Deg. F.	B. t. u. Per square foot, per degree difference per hr.
600	3.25
500	3.00
400	2.75
300	2.25

If calculations are made from results of tests, these transmission factors may seem small or too large. In case the economizer is small in capacity for the available heat, the transmission per square foot will be high, much higher than it would be if an economizer of 20 or 25 per cent larger heating surface had been installed. In a certain well known plant, the transmission for a mean gas temperature of 500 deg. was 4, and there are cases where only 2.25 was obtained by test when 3 were used in the design.

In the accompanying diagram the full line curve

represents the average transmission factors given in the table, while the dotted line curves show other factors obtained from actual test. In designing the size of an economizer it is far better to use average transmissions than factors that are very high.

In our problem, the mean gas temperature is 510 deg. therefore we may assume that 3 B. t. u. will be transmitted per square foot per degree of mean temperature difference, or $3 \times 260.5 = 781.5$ per sq. ft. per hr. Since 8,861,400 B. t. u. are to be transmitted, the area required will be $8,861,400 \div 781.5 = 11,339$ sq. ft.

Pipes Required

In the economizers now upon the market, the pipes are 9 ft. long and about 4.5 in. diameter, so that the economizer area per pipe is considered as being 12.5 sq. ft. Therefore our economizer should contain $11,339 \div 12.5 = 907$ pipes. That is, the calculation would call for 907 pipes, but the number put in would depend upon the arrangement. If the economizer is to be 11 pipes wide, probably $84 \times 11 = 924$ pipes would be used; if 10 pipes wide $92 \times 10 = 920$ pipes.

As actually installed in a large number of power houses the size is such that 4 to 5 sq. ft. are installed per boiler horsepower; our figures come within these limits for $11,339 \div 2,735 = 4.14$, which would become 4.2 if 920 pipes were used.

Industrial Water Heating

What would be the size had the object been to heat as hot as possible 150,000 lb. of water per hour the initial temperature being 80 deg.?

Under the assumed condition 3,000 boiler horsepower would furnish 9,720,000 B. t. u. available for heating water as shown by our calculation:

$3,000 \times 4 \times 25 \times 0.24 \times 180 \times 0.75 = 9,720,000.$

But the gas would probably be cooled to less than 420 deg. for the larger volume of water is not to be heated to such a high temperature, and the final temperature of the gas need not be high as the water is not to be fed to the boiler. Assuming the gas to be cooled to 340 deg., the available heat units would be

$3,000 \times 4 \times 25 \times 0.24 \times 260 + 0.75 = 14,040,000$ B.t.u.

The 150,000 lb. will be raised $14,040,000 \div 150,000 = 93$ deg., or to $93 + 80 = 173$ deg. The mean temperature of the water will be $80 \div 173 \div 2 = 126.5$. The mean gas temperature is $600 + 340 \div 2 = 470$, and the mean temperature difference $470 - 126.5 = 343.5$. Since nearly 3 B. t. u. are transmitted per hour per degree difference, $3 \times 343.5 = 1,030.5$ B. t. u. will be transmitted per square foot. The square feet of heating surface in the economizer will then be $14,040,000 \div 1,030.5 = 13,624$ sq. ft. At 12.5 sq. ft. per pipe there would be $13,624 \div 12.5 = 1,090$ pipes.

WATER SOFTENING PROCESSES

By R. E. Turner

BECAUSE of the great solvent properties of water it seldom exists naturally free from scale forming materials which remain in solution until the water has been boiled, evaporated or treated chemically. The detrimental effect upon boilers of scale which is left after the water has been evaporated has led to the invention of many processes by which this scale forming material may be kept outside of the boiler.

The objectionable constituents are, as a rule, chemical solutions of the salts and rock through which the water passes. Potatoes, starch, molasses, manure, tan bark and boiler compound are among many substances which have been used with a certain degree of success in boilers to precipitate the scale forming materials in a soft form which can be removed through the blow-off. Each of these has a certain amount of value when the scale forming material in the water is of the right kind, but in other cases the treatment of the water with these substances is positively detrimental.

A mechanical method of removing scale forming material is by means of feed water heaters and also by distillation. In each of these methods the receptacle for the scale forming material is outside of the boiler which is obviously the proper place for it.

Chemical Treatment

The first to apply a purely chemical treatment for water was Dr. Clark, an Englishman, who treated the raw water with a lime solution, to remove the carbonate of lime and magnesia. This treatment, however, left in the water the solutions of sulphates of lime and magnesia, which are the hard scale forming materials common to feed waters. To overcome these objectionable elements in boiler feed water, Dr. Porter used soda ash, which precipitated the sulphate of lime and magnesia in the form of sulphate of soda, a soft flocculent substance.

Later on a combination of these 2 systems was employed, being known as the Porter-Clark system, which consisted of treating the feed water with lime and soda ash in the proper proportions to precipitate all the carbonate and sulphate of lime and magnesia.

The first step to be taken in the process of water softening is to obtain a complete analysis of the feed water from which one may determine the quantity of chemicals which are necessary to precipitate the undesirable constituents.

TABLE I.—PROPERTIES OF INJURIOUS IMPURITIES FOUND IN FEED WATER.

SUBSTANCES IN SOLUTION	Effect on Steam Boilers	Effect on Soaps, Dyes, Tannins	Chemicals or Other Remedy Used	Method of Removal after Treatment	Substances Left in Solution
Carbonate of Lime	Soft Scale	Curdling	Lime or Heating	Sedimentation	None
Carbonate of Magnesia	"	"	"	"	"
Sulphate of Lime	Hard Scale	"	Soda Ash	"	Sulphate of Soda
Sulphate of Magnesia	"	"	Soda Ash and Lime	"	"
Chloride of Magnesia	Corrosion	"	"	"	Chloride of Soda
Chloride of Lime	"	"	Soda Ash	"	"
Sulphuric Acid	Corrosion	Decomposition	Soda Ash and Lime	"	Sulphate of Soda
Carbonic Acid Gas	"	None	Lime	"	None
Nitrate of Magnesia	"	Curdling	Lime and Soda Ash	"	Nitrate of Soda
Nitrate of Lime	"	"	"	"	"
Alkali Carbonates	Priming or Foaming	None	Blowing Off	None	Alkali Carbonates
Alkali Sulphates	"	"	"	"	Alkali Sulphates
Mud and Suspended Matter	Caking and Foaming	Interference	Sulphate of Iron and Lime	Sedimentation	None
Organic Matter	Foaming	"	"	"	———

In Table 1, is shown the properties of various objectionable impurities, which are common to boiler feed waters, and from which it will be seen that nearly all the troubles which are experienced with boilers, such as hard and soft scale and priming or foaming are due to the impurities which are taken into the boiler in the feed water. There are many other detrimental effects such as pitting, bagging, leaking and

loss of efficiency, which are traceable directly to the scale forming material contained in the water.

After a chemical analysis of the water has been made, and the proper amount of lime and soda determined for treating each gallon of water, the process is purely mechanical, and many devices have been invented for carrying on this treatment.

There are 3 distinct stages through which the treatment is carried; first, proportioning the chemicals to the water, after which a thorough mixing must take place, and then time given for the precipitate to settle before the water is fed to the boiler.

The Davidson System

One of the many systems which has met with considerable favor for softening water in extremely large

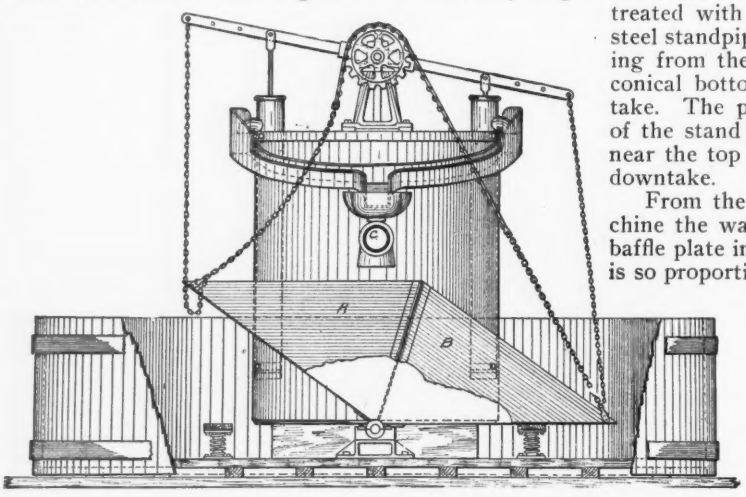


FIG. 1.—FRONT VIEW OF DAVIDSON PROPORTIONING DEVICE

quantities is that known as the Davidson system. The proportioning machine of this system consists of a measuring device, a pair of pumps, a chemical tank, and an agitating device.

By referring to Fig. 1, it will be seen that A and B are 2 triangular measuring compartments into which the untreated water from the pipe C flows. When A becomes filled it tips over and empties into the elliptical tub shown and B is presented for filling. When B becomes filled the operation repeats itself.

Fastened to the tipper are 2 chains, one operating a sprocket wheel, and through this a mechanical stirring device in the chemical tank, which keeps the chemical solution thoroughly mixed. The second chain operates the chemical pump.

Whenever the measuring device tips over a charge of chemicals is pumped and mixed with the incoming charge of water. The peculiar shape of the measuring compartments, A and B, causes a twirling motion of the in-rushing water and chemicals which brings about a thorough mixing of the water and chemicals. This machine pumps the chemicals in proportion to the amount of water passing through it, automatically, and without outside power.

This proportioning device is used in connection with either an intermittent or continuous water treating system with equally good results. In the intermittent system, 2 or 4 settling tanks are used. The treating house is built between them and has a second story high enough so that the water can flow by gravity from the proportioning chambers into any of the tanks. Lime is slacked in the lime tank, and soda ash dissolved in the soda-ash tank, and the mixture brought up to a predetermined strength on the ground floor. From here it is pumped into the chemical tank of the proportioning machine. The untreated water is delivered to the tipper and thoroughly mixed with the proper charge of chemicals and is then dumped into the elliptical tub, where it receives an additional agitation, it then flows through the inlet into whichever tank is being filled. The water is allowed to stand until chemical reaction and precipitation are completed. Then the pure, soft water is pumped through the discharge into the storage tank, or directly into the service mains, while the sludge or precipitate is drawn off through a blow-off at the bottom.

The continuous system differs from the intermittent system principally in the manner of precipitating the scale forming material after the water has been treated with the chemicals. This plan consists of a steel standpipe having a false conical bottom. Extending from the top of this standpipe to the top of the conical bottom, is an inner tube serving as a downtake. The proportioning device is placed at the top of the stand pipe, and a wood fiber filter is provided near the top in the annular ring which surrounds the downtake.

From the elliptical tank of the proportioning machine the water passes through a short pipe on to a baffle plate in the downtake tube. The downtake tube is so proportioned that the time required for the water

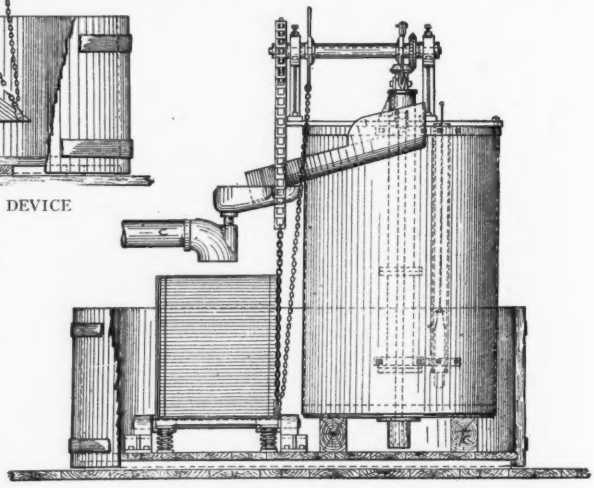


FIG. 2.—SIDE VIEW OF DAVIDSON PROPORTIONING DEVICE

to pass through it will allow chemical reaction to complete itself.

After leaving the downtake tube the treated water rises slowly to the top, while the impurities settle out into the conical bottom. Near the top of the tank the treated water passes through the wood fiber filter which removes all traces of impurities, leaving the pure, soft water to overflow through the discharge. At the apex of the conical bottom is connected the the waste pipe which is provided with a sludge valve through which the sludge is blown off from time to time.

The Miller System

Another device which is used for proportioning the chemicals to the water is the Miller Meter Motor. This machine is placed directly in the discharge line, and is operated by the water entering the machine which drives the piston forward until the spring shown on the piston rod reverses the position of the valve. The piston travels in the reverse direction until the end of the

stroke is reached when the operation is repeated. As every particle of water must pass through this cylinder its measurement is absolute.

The chemical pump which is of the outside packed type, is connected rigidly to the piston rod by the cross arm shown, so that the stroke of the chemical pump is exactly equal to that of the water piston. By this means a constant ratio between the flow of chemical solution and the flow of the treated water is maintained. A continuous flow of chemicals under pressure is thus obtained. Attached to the piston rod is a rack which actuates a pinion, and through this the agitating device in the tank thus maintaining a uniform mixture of the chemicals.

This device also is adaptable either to the intermittent or continuous system of water softening but the arrangement of settling tank and proportioning machine is quite different from that employed with the Davidson system. In the intermittent system the meter motor is placed in the treating house with the chemical tank in a pit in the floor. The proper amount of lime is slacked in the lime tank and soda ash dissolved in the soda-ash tank. The 2 are then mixed and diluted to the proper strength.

The untreated water passes through the meter motor after which the chemicals are injected into it in the proper proportions at the floor line in the treating house, thus giving treatment under pressure and a thorough mixture is secured before the treated water enters the settling tank where it is still further agitated in the mixing box.

After the tank is filled it is allowed to stand until the impurities are settled out. The pure, soft water is taken out through the discharge pipe, and either pumped into a storage tank or run through pipes directly to the point of service. The discharge pipe is equipped with a float on one end and a swinging joint on the other end so that the soft water is always taken from nearest the surface. A sludge valve is provided so that the precipitate can be run off from time to time.

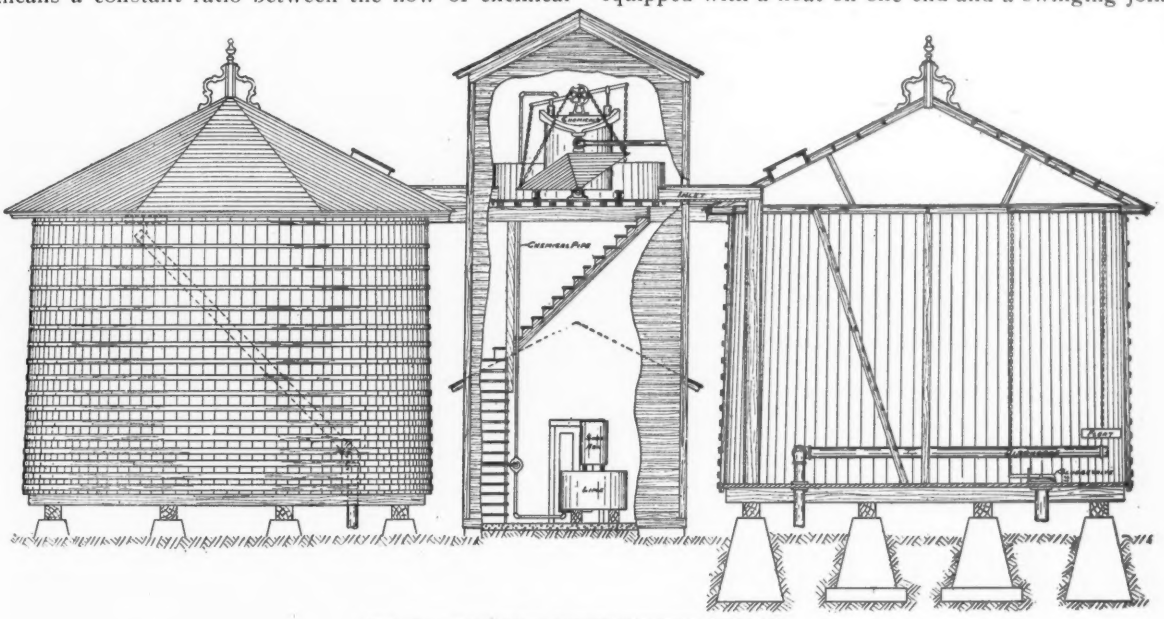


FIG. 3.—DAVIDSON INTERMITTENT SYSTEM

The Miller continuous system of water softening differs from the intermittent system in that but one stand pipe is employed, this being provided with a false conical bottom, and a mixing hood above the base of the conical bottom under which the treated water is discharged and the precipitate allowed to settle out in to the conical bottom from which it is drawn out from time to time through the sludge valve.

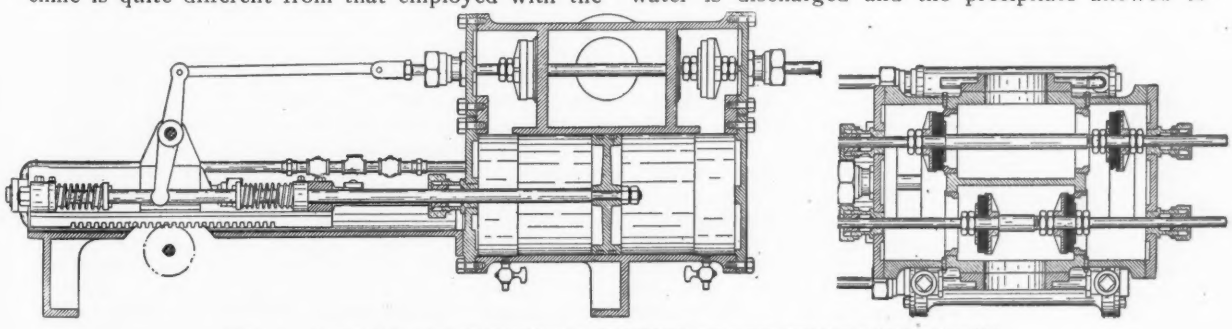


FIG. 4.—VERTICAL AND HORIZONTAL SECTIONS OF THE MILLER METER MOTOR

REPORTS FROM WASHINGTON regarding the lengthy cruise recently completed by the United States steamer Cheyenne, in which oil was used as fuel, are to the effect that the vessel was able to steam faster than with coal, and that her steaming radius of 1,500 miles, which was her limit when burning coal, has been increased by the use of oil to 2,300 miles.—Gas Review.

PUMP VALVES

TYPES AND MATERIALS USED FOR BOILER FEED PUMP VALVES

By W. E. Sanders

PUMP valves are rather insignificant in a power plant but they can cause a great deal of trouble. A great deal depends upon the quality of the valve and more depends on having a valve that is adapted to the service required of it. The excuse for this article lies in the fact, while most engineers know what kind of valve to use, there are a great many who show by the questions which they ask and the way in which they use valves, that they are not acquainted with the principles by which the valves act, or rather along which valves are made.

Disk Valves

Valves are most commonly used in boiler feed pumps and in similar pumps for ordinary service. These valves are generally made in the form of a disk which covers a grating or gridiron, usually of brass with the ribs radial and made so that it can either be screwed or forced into position. From the center of the valve seat rises a stud bolt, the stud bolt passing through the valve, the guard back of the valve, and the cone shaped spring which quickens the return of the valve to its seat. Some times brass disks are used, in which case the disk is generally beveled at the rim and the seat has a corresponding bevel in which the valve rests. These valves are more expensive, and if they are in any way worn or scored by the scouring action of the liquid, it is harder to replace them, and as a result there are comparatively few valves used of this construction.

This article deals particularly with rubber composition valves and we are interested in the brass valve particularly when it has preceded the use of rubber valves. Often rubber disks will be used in place of the brass disks. When this is done the valve seat should first be removed and planed off to a level surface. The rubber cannot seat itself well on a surface that is very uneven, and often rubber valves are condemned when the difficulty lies, not with the valve but with the valve seat. This is particularly true where rubber valve disks are used to replace brass disks.

A rubber disk is used because it is soft and adapts itself to the slight unevenness of the seat and gives a perfect seating, thereby preventing any slip due to some slight opening left by imperfect seating. Back of the rubber disk there should always be a brass guard plate. This may extend flush with the edge of the valve or it may have a lip which partially encloses the edge of the valve. The object of this guard is to stiffen the valve and by its use a much thinner rubber valve can be used. More than this it distributes the pressure evenly over the top of the valve, and does not distort the valve but makes the wear even, so that a longer service is obtained. Back of this brass guard plate is a spring which is used simply to secure a quicker closing and prevent any possibility of the valve being hung up or catching on the stud bolt, which acts as a keeper or guide to prevent entire displacement.

Classification of Rubber Valves

There are, roughly speaking, 3 classes of service for boiler feed pumps. This classification is determined by the temperature of the feed water. Feed water is supplied to a boiler cold, that is to say, its ordinary temperature is under 100 deg.; semi-hot, by which we mean it has been heated more or less by whatever exhaust steam may be utilized easily, and this water runs from 100 to about 160 deg.; or hot water which runs from 160 deg. up to 210 deg., or possibly higher.

Ordinarily, water supplied to boilers does not reach a temperature higher than 210 or 211 deg. This makes a classification of the pump valve which can be used. Rubber softens under the influence of heat. A valve must have a certain degree of softness so that it can seat itself properly and allow no leak. If a valve has the proper degree of softness for cold water and then is subjected to hot water, it will soften up much more and so much so that it will be battered out of shape by the repeated shocks and will go to pieces. For hot water a valve should be used that when cold is hard, but when heated up by the water softens up enough to seat well, but is at the same time stiff enough to withstand the repeated shocks in service.

These valves are called, soft or medium or hard valves, or as sometimes classified, cold-water valves, warm-water valves and hot-water valves. These valves are tested easily by the thumb nail which will indent easily a cold-water valve, with more difficulty a warm-water valve, and which fails to make any impression on a hot-water valve. And more than this, if a piece of a cold-water valve is cut off with a knife it will be seen to have considerable stretch and tensile strength. If a piece is cut off a warm-water valve it will show less stretch but more tensile strength. It is difficult to cut a piece from a hot-water valve. It comes off more in the form of chips and has no stretch and cannot easily be tested for tensile strength but if it were so tested it would show a high strength. These tests are all made, of course, when the valves are cold. If the hot-water valves were tested while hot, they would act differently.

Detecting Quality

There are usually 3 grades of each of these valves, and in a general way the price of the valve is an indication of its quality. It is a fundamental fact that the amount of rubber in a valve is the amount of binding substance in the valve. That is to say, it is the rubber that holds the compound together. A crude illustration would be the power of glue to hold sawdust together; the larger the proportion of glue the more firmly the sawdust will be held together. If there was not much glue present the mass would break apart comparatively easily. The same principle holds with valves.

A cold-water valve which has little rubber can easily be broken up by service. On the other hand a cold water valve with a large amount of rubber will be tougher and will last for a long time. It is the rubber in valves which is the expensive material, and in a general way, a valve which is more costly means a valve that has more rubber in it and therefore a better valve. Where an engineer is likely to make a mistake is in buying valves from a salesman whom he does not know and whose statements he takes without having proved them. It is a great temptation to a salesman to sell a cheaper valve at a higher price and run the risk of its giving satisfactory service. This temptation is greater because very few engineers can judge of a valve by inspection. Most of the valves have the same gray color and there is no way of telling the compound except as a result of experience or analysis.

HOW THE NEW CHIEF MADE GOOD

SECURING RECOGNITION OF ABILITY

By Geo. H. Wallace

SUPERINTENDENT MATHER and Chief Engineer George Willard approached the private office of John Gautelbeim very much in the same manner as does little Willie when he investigates the giant firecracker that failed to cut loose on schedule time.

Both men knew that the interview would not be a session of the International Peace Conference, but rather felt that it would be more like Admiral "Bob" Evans and the "Big 16" getting right down to brass tacks, and they were not disappointed.

They paused at the door and exchanged a glance that meant more than would a printed volume. To sum it up it meant "Ve Dutch must togedder sticken." Willard rapped firmly on the oaken panel.

"Come in," said a gruff voice that sounded like filing a crosscut saw. As their forms entered the doorway, Gautelbeim whirled around in his swivel chair like a grizzly bear at bay, and roared:

"Well!"

"That's a hole in the ground," said Willard in his gentle voice as if he had merely passed the time of day.

"What's that?"

"I say, a well is a hole in the ground," reiterated Willard as he helped himself to a chair.

"Young man, I like your nerve!"

"Thank you, very much, Mr. Gautelbeim, I am very glad to know that you like something about me," said Willard with a smile, while Mather concealed a hearty laugh with difficulty. This last remark of Willard's snapped the slender cord that held Gautelbeim in restraint, and, pounding his desk vigorously with his massive fist, he turned full on Willard and fairly howled:

"Young man," as he choked with pent up wrath, "Young man, that was a dirty trick you played on me the other day—a dirty trick, I say—to get me out of your engine room, but this is my office and you get out or I'll throw you out!"

Willard paid not the slightest attention to this sweeping threat but busied himself unwrapping his roll of drawings.

"Well, why don't you get out!" fairly shrieked the manager.

"Who, me? Well, I guess I'll let you throw me out if it will be a pleasure to you. Mr. Mather will you please hold one corner of this drawing and, Mr. Gautelbeim the other, if he will—please"—(looking him square in the eye)—"we will proceed to business. Yes like that, thank you, gentlemen."

There was positively no way of evading those brown eyes and once more the cruel gray ones of John Gautelbeim succumbed to them.

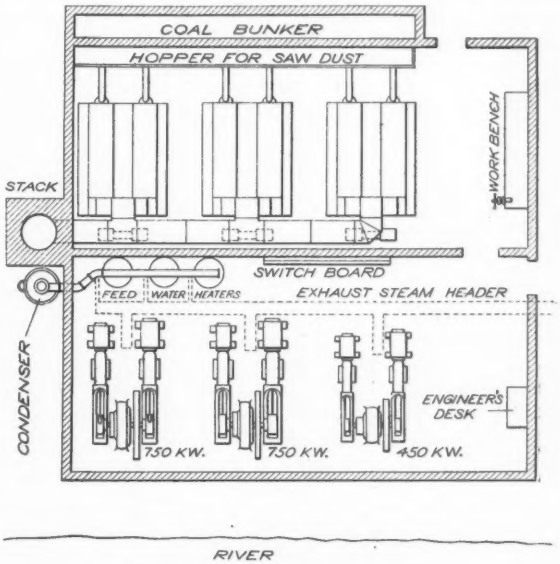
"You will recall, Mr. Gautelbeim that we have touched briefly on this pressing subject several times before, of concentrating our power equipment in a central plant conveniently located in which, power, light and heat (when necessary) can be generated, and from which it can be distributed with a minimum cost. Since I have been with your firm, I have carefully studied the situation and Mr. Mather, has cheerfully contributed his plans in order that we might work in harmony for the common good of the firm."

"Now," continued Willard, warming up to his subject, "there is not the least shadow of a doubt but that in 2 yr. time the output of this firm will be more than doubled. This is very evident by the excellent showing of the past 4 months—say since Dec. 1 last—notwithstanding the fact that the winter season is usually dull in every line, everywhere.

"Now, Mr. Gautelbeim, we are right up against it for power; right bump up against the last ditch and no way out of it. Mr. Mather here, is adding modern machinery every day to keep up with the orders both at home and abroad and we can't pull much, if any more. The Hartford people have supported my cut in pressure of 5 to 10 lb. on all the old boilers and we are virtually running on hot water now—not steam.

"Just suppose, sir, that one or two of those old 2-flue or cylinder boilers, or engines would give way under the strain and 'let go' and kill a dozen men. Where would we be?"

"Well what if they did bust or let go or break as you try to make me believe," exclaimed Gautelbeim



INITIAL PLAN OF POWER HOUSE

sarcastically, still mad but cooled off a little. "What if they did? Why I could get another engine and boiler on the grounds in a week's time and don't you forget it. Here," and he jerked a bundle of papers viciously out of his desk and hastily selected one, "Here, let me show you something. What do you think of this?" reading from a bargain sheet:

"For Sale—One 15.5 by 32 plain slide valve box bed engine and 12 good boilers, good for 75 lb. steam, with stack. Can be seen at Colby, Wis. Have not been used in five years. Reason, no log supply for saw mill. Price $600 in place.

"There, Willard, what do you think of that?" and while Gautelbeim was forcing the remainder of the paper back into his desk, Willard tossed the "bargain sheet" into the burning grate, "and as for a few men" continued the manager with a snap of his finger and a deprecatory shrug of his massive shoulder, "why, I can get plenty—plenty—of Hunyocks any day that can run a shaper, or rip saw good enough for me."

"Not any more though while I am here," put in Mather, as John began to search for his 'bargain sheet' but ceased at the unusual remark of the superintendent, "not for me. You can't make a shaper specialist out of a shovel manipulator and you can't assemble any machinery finer than railroad ties and compete in the world's market, with a bunch of fruit peddlers and Black Hand Artists."

The superintendent spoke but seldom and when he did, his hearers usually took notice. Gautelbeim forgot all about his bargain engine and boiler and rubbed his chin and said:

"Well, I don't know—maybe. But what is this anyway, Willard?" said he with some interest as he turned again to the drawing.

"This is a brief sketch of what I think is about what the conditions here require," continued Willard explaining. "I propose to locate this power plant down along the river and run everything condensing except at such times as exhaust steam shall be used for heating purposes. We will arrange for 3 horizontal cross compound Corliss engines, 2 of about 750 kw. and one of about 450 kw."

"What's a kw.?" broke in Gautelbeim with disgust, "I never saw or heard of such a thing before. Got any on any of the old engines?"

"Kw. is the abbreviated form demanded by modern methods of the more complete and euphonious expression of kilowatt, which means 1,000 watts; and 746 watts equals one horsepower and 750 kilowatts equals about 1,000 horsepower," said Willard with a rapidity that showed great familiarity with the abbreviation.

"M-m-m-a-yes, I see," and John bit the end off a cigar like the snap of a bear trap, just as if he really understood any more about it than he did the week before.

Willard put forth the best arguments that were in him, for he knew that if he fell down at this time, now that the G. M. was in a sense, becoming domesticated, that it would be doubly hard to recover lost ground at the next interview.

The superintendent simply held his corner of the drawing and by his silence did much to convince Gautelbeim that Willard knew what he was talking about. All the advantages that he could possibly think of, Willard advanced forcefully in favor of his pet scheme and he left no loop hole for the wily manager to crawl out of.

Finally Gautelbeim straightened up from the drawing, put his elbows on the arms of his revolving chair and placing the tips of his outstretched fingers together, slowly swung forth and back, thinking seriously.

"Well, I hardly know what to say about it. I never had any such trouble before, arranging for engines and boilers. Maybe you gentlemen know best. Anyway I'll think it over. Good day," and without another word, Mather and Willard took their departure. Neither spoke till they returned to the engine room where Fritz kept watch over his old slide valve. Once inside the door, they shook hands vigorously while Fritz looked on in wonder.

"He's as good as in the boat already," chuckled Willard and Mather asserted that they had the right kind of bait.

"I bets hunner thalers doze two fellers pen goin' fishin' Sunday," thought Fritz as he picked up a long necked oil can. The fact that they were apparently happy and jovial after a visit to the office of the manager was beyond the scope of his understanding and like a good engineer he didn't interfere but went ahead with his oiling up.

Finally after a short conversation, Mather went out to the factory and left Willard alone with his victory. Fritz looked at him a while and chuckling softly to himself thought, "Ef I don't misses my guesses, dere vos been sometings didding porty soon. Ich veis nicht vos es ist aber I tinks de chief haf kicked ole Yon oudt of his own office already, yet!" and Fritz set down the oil can and attacked the shavings with vigor, little knowing how close to the truth he really was.

Willard was so absorbed with his drawings that it required the second merry jingle of the phone on his desk to disturb him.

"Hello! hello Willard, this is Gautelbeim. Say, can you come up to my house this evening? I want to talk to you some more on that power plant subject. I was not quite myself this afternoon; quite upset, you know. Suppose you come up to dinner if you will. Come at 6:30 and that will give us a chance to discuss the matter at length afterwards."

"Thank you very much, Mr. Gautelbeim; I think I can arrange to be there at 6:30 all right," and hanging up the receiver Willard grabbed his hat and rushed out to get a shave, the thoughts of Gautelbeim's beautiful daughter, Dorothy being uppermost in his mind.

Fritz was amazed at the hasty departure of his chief and as he wiped his pudgy hands with a piece of waste he soliloquised.

"Ach donnervedder! Vos is lose! I pets a helf a thaler date he goes ofer to yump on ole Yon now ven he's Irish vos oop! Ole Yon he petter skveeze inter der safe till de scmoke plows ofer," and Fritz, finding that it was 5:30, blew the whistle.

NEW ALUMINUM SOLDER CONTAINS TIN

It is stated in a French contemporary that the best soldering medium for aluminum is an alloy of that metal and tin. The proportions vary according to the extent to which the soldered articles are intended to be worked; 45 parts of tin and 15 of aluminum forming a good solder for such as are to be shaped afterward. A harder solder, but less easily applied with the soldering iron, is prepared by melting 4½ parts of red copper, to which are then added 3½ parts of zinc and 4½ of tin, the heating being continued until a homogeneous alloy is obtained.

In The Metal Industry it is stated that the surface of all aluminum is covered with a thin, invisible coating of aluminum oxide, and that this coating forms instantly after the surface is cleaned; it is very refractory, and is soluble only in hydrofluoric acid. It is necessary, therefore, to remove this coating of oxide simultaneously with the soldering operation, and this is best accomplished mechanically by abrading the surface with a steel or brass scratch brush while the solder on the surface is still molten.

MEAN PISTON SPEED of an engine is found by multiplying twice the stroke in feet by the revolution per minute. The common piston speed for small horizontal engines of amout 12-in. stroke is from 300 to 400 ft. per minute, but the large and high class small engines run at about 700 ft. per minute while locomotive systems frequently exceed 900 and even 1,000 ft. per minute.

THE LATEST ADVANCEMENT in the art of high voltage power transmission is that outlined by the requirements of the Stanislaus Power Co., of California, the voltage in this case being 138,500. This voltage is obtained by water-cooled transformers of 3,750 kw. capacity being supplied with single-phase current at 60 cycles per second, while the low tension voltage is 12,100.

INCREASING CAPACITY AND SAFETY OF COAL MINES

LIMITATION of the capacity of a coal mine is frequently due, not to the amount of coal in the mine nor to the facilities for mining the coal, but to the facilities for getting coal to the surface. Those who are familiar with the process know that in the usual method a hoist is employed which takes up one car at a time from the mine level to the surface, and dumps this car over the tipple at the top onto the screens. It is arranged so that while a full car is coming up an empty car is going down, but the capacity of the hoist for one lift is limited by the capacity of a car.

There is always danger that the engineer who is responsible for the safe hoisting of the coal may misunderstand signals, the cagers or men who load the cars on the hoist may not get clear of the hoist before it starts, or if the hoist happens to go down at the wrong time the cager may be caught by the car.

A new system of hoisting coal has recently been devised and patented by Andrew Flesher, of Taylorville, Ill., and a plant is now in operation at the mine of the Co-operative Coal Mining Co., Breese, Ill. Coal is dumped from cars into hoppers at the pit bottom and from these into cages which will hold several cars of coal. As each hoist brings up several cars instead of a single car, it is unnecesary to run the hoist so fast, which in itself takes a great strain off the engineer and reduces the likelihood of something going wrong, and also the men who load the cages with coal are removed from the possibility of injury.

The cage automatically discharges the coal at the top of the hoist, so that no attention is required at that point. Of course, the system can be used for hoisting any kind of ore from any sort of a mine, as well as coal.

Most of the accidents in mine hoisting come from the fact that the engineer when engaged in this work has to work rapidly, receiving and giving signals and operating the machinery, and has always on his nerves the possibility of an accident to those working about the pit bottom. The ordinary mine car carries 3 tons, while the cage as planned in the Flesher system holds 12 tons, so that a single hoist will carry as much with the cage as would 4 hoists with the single car method. It is evident, therefore, that hoisting only half as fast as by the old method the coal could be raised twice as fast.

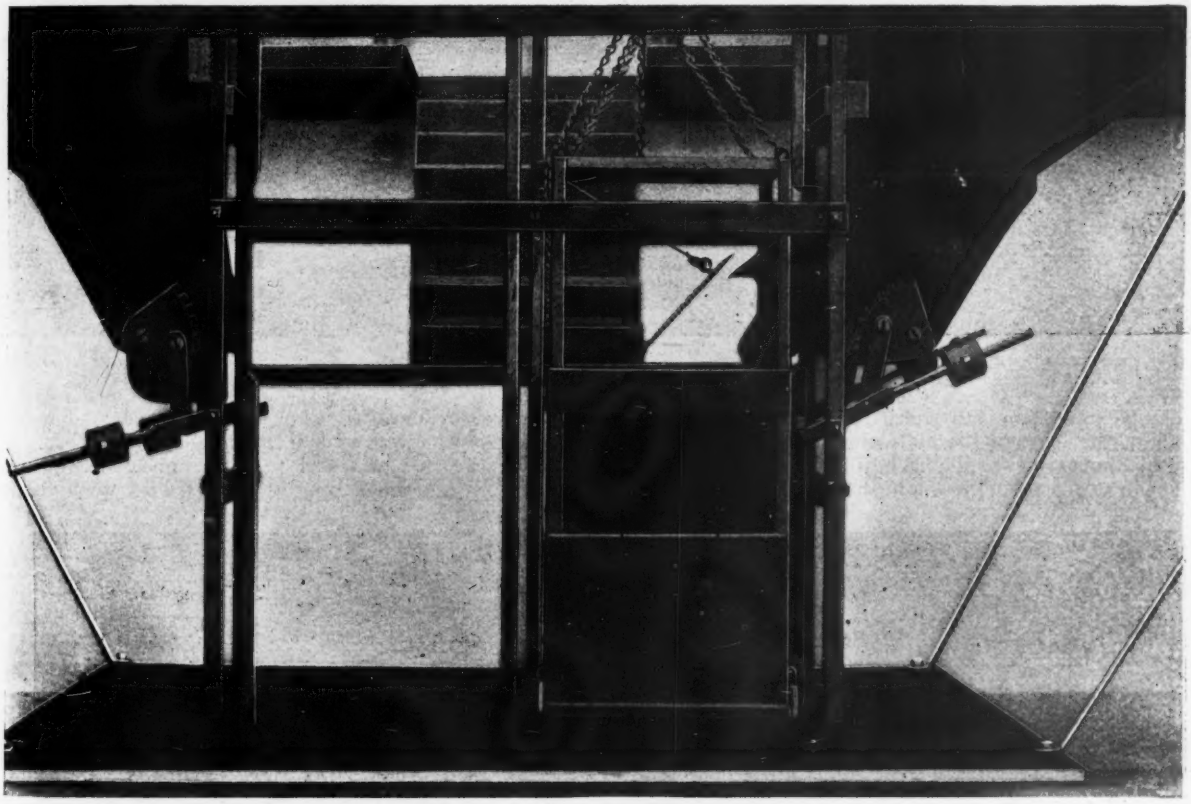


FIG. I.—CAR AT PIT BOTTOM READY TO LOAD

As an example, in operating a mine with a shaft 600 ft. deep and cars of 3 tons capacity by the old method of hoisting one car at a time, in an 8-hour shift the engineer working steadily could hoist 2,100 tons by 700 trips up and down the shaft. By the new method the engineer would hoist 2,100 tons making 175 trips up and down the shaft, thus eliminating 0.75 of the wear on the machinery. Operating at the same capacity there would be 315,000 ft. less travel for the cable during the 8-hour shift.

Two cages are employed, as shown in the illustrations, with suitable guide ways in the shaft, these guides being placed in the center of gravity of the cage and not in the center of the shaft. On top of each cage

is a platform for lifting miners or others whose duties require them to enter and leave the mine. A trip on the bottom of the cage automatically discharges the load at the top and also automatically loads the cage from a receiving hopper at the pit bottom.

To catch the cage in case of accident a horizontal shaft extends the full width of the cage on each side about the level of the platform or near the top of the coal compartment. On each of these shafts is mounted a wing or plate with a long bearing turntable on the shaft, and these wings have the outer edges provided with catch points which are adapted to catch in the curbing of the shaft. The wings extend approximately the full width of the cage to provide maximum catching surface.

At ordinary hoisting speed the capacity of each cage for an 8-hr. shift is 6000 tons and the cages are built of such strength and simplicity that they require a minimum of attention.

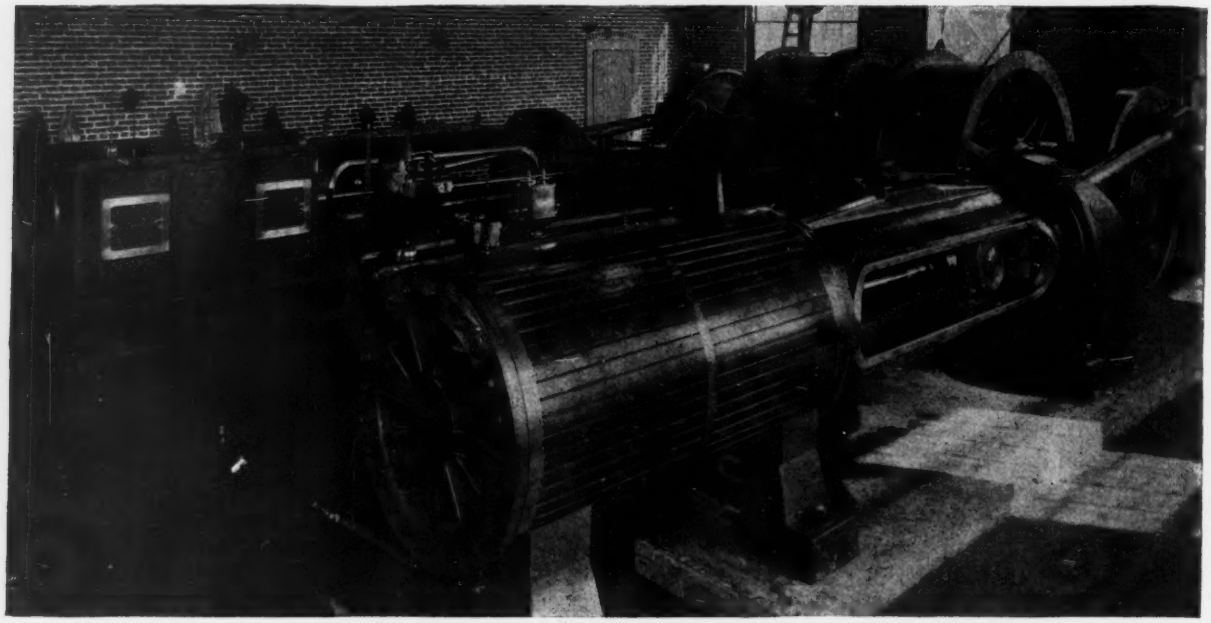


FIG. 2.—ENGINES FOR DRIVING THE HOISTING DRUMS

Figure 1 shows the cage at the pit bottom opened to the hopper for receiving coal. The coal on entering the cage has no great fall but slides in until the cage is filled, so that the filling of the cage occupies about the same time that is required to put a single car on the cage. These receiving hoppers at the pit bottom are kept loading continuously while the hoists are

FIG. 3.—DUMPING INTO RECEIVERS AT THE PIT BOTTOM

making the trips up and down. The opposite cage chamber in this view shows the chute which connects to the receiving hopper tightly closed and the opening in the guides that allows the connecting apron between hopper and cage to revolve when opening and closing. On this side of the cage are 3 shoes so that 2

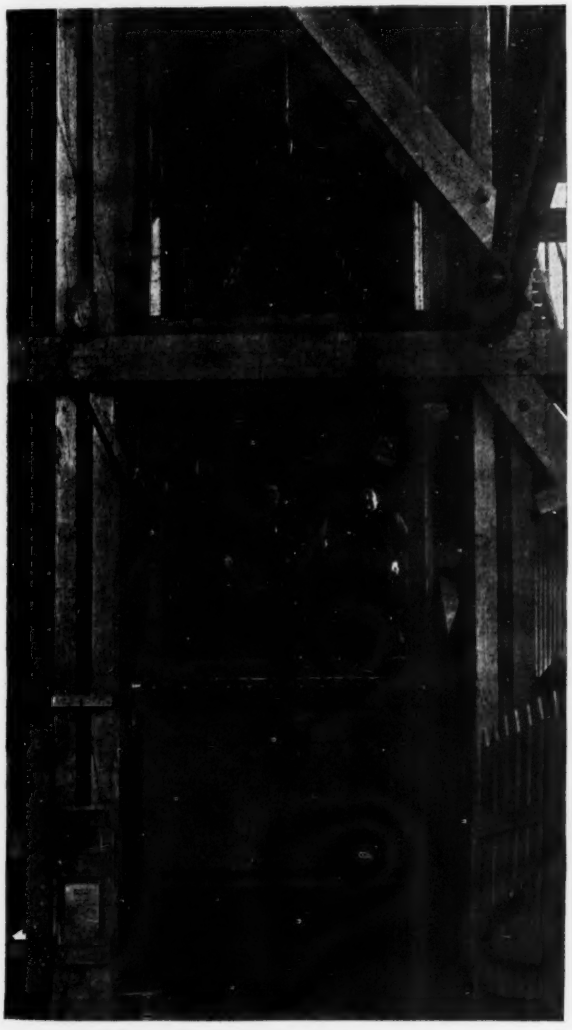


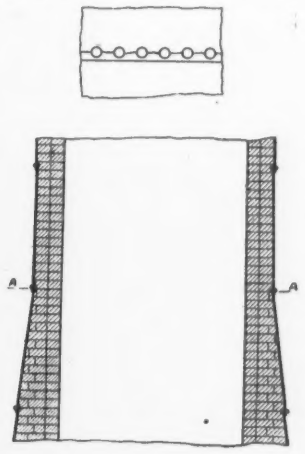
FIG. 4.—CAGE READY TO DESCEND WITH PASSENGERS

shoes are on the guides all the time, even when passing the opening. The apron or chute is automatically opened when the cage descends and closed when the cage ascends. As the cagers at the pit bottom dump the cars into the receiving hoppers and not into the hoist cages, they are never at any time in position to be caught by the cages, either descending or ascending.

PROPERLY SPEAKING, THE AEROPLANE as we now know it is hardly 2 years old. As an indication of the way it is looked upon in this country, attention is called to the formation of the Wright Co. of New York, capitalized at $1,000,000, of which Wilbur Wright is president and Orville Wright is vice-president. This company is formed for the commercial manufacture of aeroplanes of the Wright pattern. The first factory will be opened at Dayton, the home of the Wrights.

EFFECT OF STACK EXPANSION

Expansion is a recognized fact in the operation of a stack, but so much expansion as was the case in a large stack at Bethlehem, Pa., described by W. J. Cummer in Popular Mechanics, is unusual. This stack was at one of the steel plants and on examination it was found that



BREAK OF STACK FROM EXPANSION OF BRICKWORK

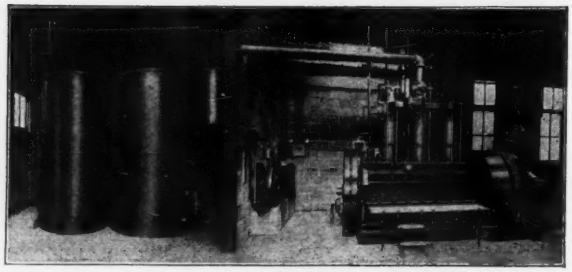
at the point where the section changes from conical to cylindrical, the expansion had torn apart the plate between rivet holes, and the ring above the joint was bound 1¼ in. higher than its original position. Evidently the brick work in the upper part of the stack had risen, carrying with it the outer casing and with sufficient force to tear the joint all the way round. As the brickwork in this case is not sufficient to insure stability it is remarkable that the stack has not overturned. The repair is to be made by putting a band around the separated joint and inserting a double row of tap bolts in slotted holes to allow for the expansion and contraction.

THE POWER OF LARGE GUNS

A gun may properly be considered as a prime mover, and its output may be expressed in terms of horsepower. As, however, the period of time during which energy is exerted is very short, the horsepower expressed in figures becomes rather startling. A calculation involving the horsepower of the large 16-in. gun mounted at Sandy Hook, for instance, will reveal more than anything else the enormous size and power of this gun. The projectile weighs 2,370 lb. and has a muzzle velocity of 2,300 ft. per second. The energy developed at the muzzle is about 88,000 foot-tons. If we assume that the projectile moves through a distance of 33 ft. within the gun while acquiring the given velocity, and that the acceleration of the projectile is uniform until the muzzle is reached, the mean velocity of the projectile while within the bore would be $2{,}300 \div 2 = 1{,}150$ ft. per second, and the period of time during which the energy of 88,000 foot-tons is developed would be $33 \div 1{,}150 = 1/35$ of a second. This corresponds to a total of $88{,}000 \times 35 \times 60 = 184{,}800{,}000$ foot-tons per minute. Since the horsepower = 33,000 foot-pounds, or 14.7 foot-tons per minute, we have $184{,}800{,}000 \div 14.7 = 12{,}600{,}000$ hp., as the power developed by the gun during the period and conditions mentioned.—Machinery.

FIRE BRICK LINING in a chimney need not, except in short chimneys, extend higher than ½ or ⅔ the height, but the other portion should be lined with sound hard brick.

Gas Producers And Engines



A NOVEL FEED WATER HEATER TEST

USE of the heat from the exhaust of a gas engine has been attempted in one way and another at various times, one of the most favored methods being to heat water with the exhaust gases from the engine and use this hot water either for industrial work or the hot water heating of buildings. In this connection a test recently completed of the Riblet heater, made by the Williams Tool Co., of Erie, Pa., at the works of the Westinghouse Machine Co. and in connection with a Westinghouse 200-hp. gas engine, is of interest.

The Riblet heater is a radical departure in heater design; it is made entirely of close grain gray cast iron and has a casing with but 4 joints, all external, and the only piping is for the draining away of condensed steam. Exhaust steam enters through several ports at the bottom of the casing, passes upward 3 to 5 times across the sections through which the feed water flows, and leaves at the top. The feed water enters the section at the top through a single port, flows in a zigzag course downward and leaves at the bottom. Both steam and water flow through flat passages which are alternated so that a large amount of surface is obtained in a small space.

Cast iron does not readily corrode, is not affected by electrolysis or acids and scale adheres to it but little. Such sediment as does collect can readily be cleaned out by removing the circulation plates. The main member is cast in one section and the circulation plates bolted to it so that they are easily taken out.

It is a well-known fact that only 30 per cent of the heat units of the gas are consumed in developing power in a gas engine and that the balance is wasted through the exhaust and the water used to cool the engine. The exhaust has a temperature of from 1000 to 1200 deg., and the Transverse Current heater is designed to save all the heat from both the jacket water and exhaust and make it available for heating water for whatever purpose desired in the factory, hotel, office building or laundry.

In the test referred to the engine was operated on natural gas. It was a 16 by 18-in., used in connection with a No. 8 heater. In all, 4 tests were made, but 2 of these will show the general character of the results.

In the first test at full load water entered the jackets of the gas engine cylinders at 47 deg. F., was passed from these to the inlet of the heater, entering that apparatus at 131 deg., and left the heater at 190 deg. This meant an increase in the jackets of 84 deg. and in the heater of 59 deg. in the temperature of the water,

PROPORTION OF HEATING SURFACE AND WATER HEATED TO GAS ENGINE HORSEPOWER

Full Load

Engine H. P.	No. of Heater	Sq. ft. of Heater	Amount of Water in Lbs. Heated in One Hour from both Exhaust and Jackets					Amount of Water Heated in One Hour from Exhaust only					B. T. U. Absorbed	
			150° Lbs.	180° Lbs.	190° Lbs.	200° Lbs.	210° Lbs.	150° Lbs.	130° Lbs.	190° Lbs.	200° Lbs.	210° Lbs.	From Jackets & Exhaust	From Exhaust only
10	1	17	873	670	620	580	545	365	280	260	245	220	87380	36710
25	2	25	2180	1675	1550	1470	1360	910	700	650	610	550	218450	91775
50	4	50	4365	3350	3100	2940	2725	1825	1400	1300	1225	1100	436900	183550
75	5	67	6540	5000	4650	4410	4080	2730	2100	1950	1830	1650	655350	275325
100	7	100	8730	6700	6200	5800	5450	3650	2800	2600	2450	2200	873800	367100
150	8	134	13080	10000	9300	8820	8160	5475	4200	3900	3675	3300	1310070	550650
200	10	200	16460	13400	12400	11600	10900	7300	5600	5200	4900	4400	1747600	734200
250	11	267	21810	16700	15500	14620	13610	9125	7000	6500	6125	5500	2184500	917750
300	12	333	25190	20100	18600	17400	16350	10980	8400	7800	7350	6600	2621400	1101300

Half Load

			Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		
10	1	17	560	430	400	375	350	210	160	150	140	130	56320	21120
25	2	25	1400	1075	1000	885	825	525	400	375	350	325	140800	52800
50	4	50	2800	2150	2000	1775	1650	1050	800	750	700	650	281600	105600
75	5	67	4200	3225	3000	2660	2475	1575	1200	1125	1050	975	422400	158400
100	7	100	5600	4300	4000	3550	3300	2100	1600	1500	1400	1300	563200	211200
150	8	134	8400	6450	6000	5325	4950	3150	2400	2250	2100	1950	844800	316800
200	10	200	11200	8600	8000	7100	6600	4200	3200	3000	2800	2600	1126400	422400
250	11	267	14400	10750	10000	8875	8250	5250	4000	3750	3500	3250	1408000	528000
300	12	333	16800	12900	12000	10650	9900	6300	4800	4500	4200	3900	1689600	633600

and this was passed through the heater at the rate of 8175 lb. an hour. The temperature of the exhaust gases at the outlet of the heater was 265 deg. From these observations we get that the heat per hour taken up by the water from the jackets would be 687,000 B. t. u. and taken up by the heater would be 482,000 B. t. u., or a total of 1,169,000 B. t. u. per hour taken up by the water.

The engine gave 201 brake horsepower and used 2175 cu. ft. of natural gas at 62 deg. F. and 30 in. mercury pressure, having a heat value of 966 B. t. u. per cubic foot. This would make the heat per hour to the engine 2,100,000 B. t. u., and the heat equivalent of the brake horsepower would be 512,000 B. t. u. per hour. We would then have the heat furnished to the engine distributed as follows: Transformed into work, 24.4 per cent; absorbed by the jackets, 32.7 per cent; absorbed by the heater, 22.9 per cent; exhaust and radiation, 20 per cent; 73.5 per cent of the heat available for heating is utilized by the engine jacket and heater.

In the test at half-load on the engine, the water entered the jacket at 47 deg., entered the heater at 140 deg. average, and left the heater at 196 deg., thus gaining 93 deg. in the jackets and 56 in the heater. The gases entered the heater at 560 deg., and at the outlet from the heater had a temperature of 217 deg. Water was used at the rate of 5050 lb. an hour and took up in the jackets 470,000 B. t. u. an hour, and in the heater 283,000 B. t. u. an hour.

The brake horsepower of the engine was 100.8, the gas used 1411 cu. ft. per hour with the same heat value as before. This gave as heat supplied to the engine 1,363,000 B. t. u. an hour and utilized by the engine 256,500 B. t. u. an hour, or 18.8 per cent of the total. The jackets absorbed 34.5 per cent, the heater 20.8 per cent, and exhaust and radiation accounted for 29.8 per cent. Efficiency of jacket and heater was 68.1 per cent.

From these figures it is evident that if a larger heater had been used, containing at least 200 sq. ft. heating surface instead of only 134 sq. ft., the per cent to exhaust and radiation would have been considerably decreased and the economic results would have shown quite a little higher.

FIG. 1.—EXTERNAL VIEW OF RIBLET HEATER

FIG. 2.—INTERNAL CONSTRUCTION OF MAIN SECTION

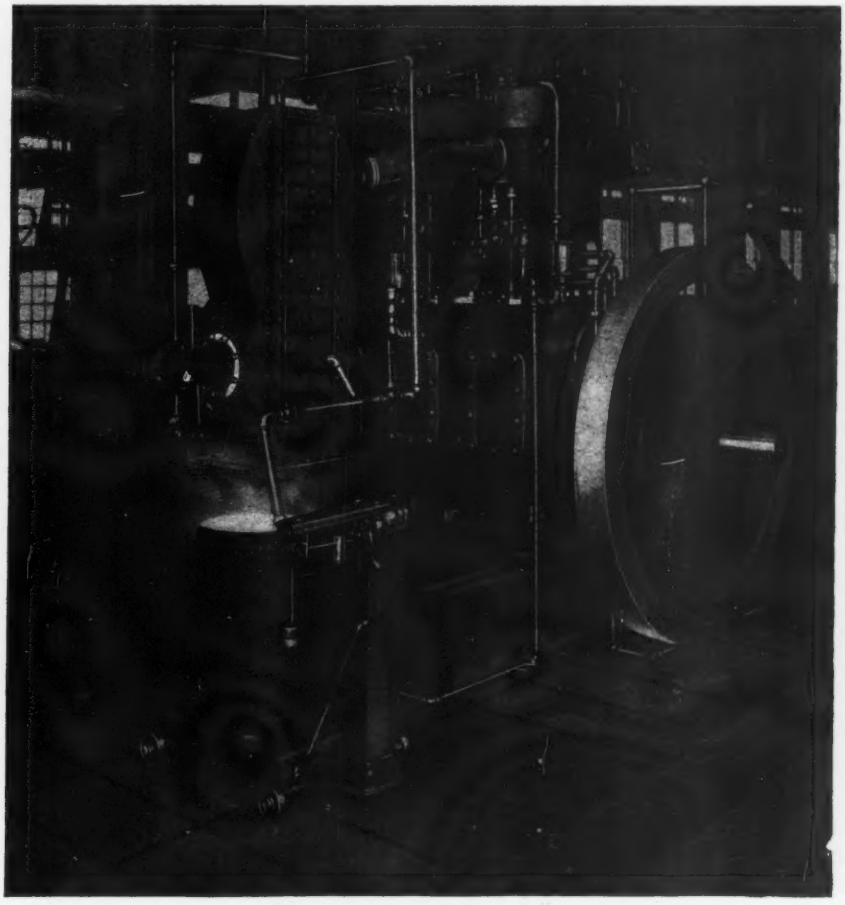


FIG. 3.—HEATER ARRANGED FOR TEST WITH GAS ENGINE

Based on these tests the Williams Tool Co., of Erie, Pa., which manufactures the Riblet heater, has computed a table showing the horsepower of gas engines and the number of square feet of heating surface required to heat given quantities of water per hour to any temperature. This table is as shown herewith.

For a 500-hp. engine, the figures given in the table for 250 hp. should be multiplied by 2, and for a 1000-hp. engine multiply the 250-hp. figures by 4. To reduce the pounds of water to gallons, divide the pounds of water by 8.3, and to find the number of pounds of coal required to heat the same quantity of water to the same temperature in one hour, burning the coal under a boiler, divide the B. t. u. absorbed by 7200.

APPROACH OF THEORY AND PRACTICE IN MODERN GAS ENGINES*

By A. J. Firth

IT is with sincere pleasure that I avail myself of an opportunity to bear witness to the progress made in the excellence and reliability of the modern gas engine. The high standard that has been attained is patent to everyone who has eyes to see, and is a subject for congratulations to all concerned.

There is nothing more striking than the contrast between the illustration of the older gas engine and the simple outlines of modern machines; instead of the curves and architectural adornments of frame, with ogees and curves of beauty sweeping from cylinder to main bearing, we have today the simple straight line contours of rigidity and economy. They are built for work, and straight lines and steel ties, in the line of strains, absence of cross stress in cast material insures steadiness and long life—it is the perfection of true theory, the mark of good practice.

Simplicity of detail governing the control of good fuel mixtures, absence of means for pre-ignitions, insurance of igniters with ample valve, port openings and connections have become more than frequent, and while all details from year to year are more certain in action and intelligent in design, there are some who are hoping for a fool proof device that will insure that our engines decrease to the utmost the fuel frequently wasted in the exhaust unconsumed. A careful operator can avoid this trouble, but it is hoped that in the near future we will be independent of his judgment.

This operation is an illustration of the approach of theory and practice. The theory being not so very far back that anyone could run a gas engine, whether he was a mechanic or not. We know by practice that if an owner or a manufacturer heeds the true interests of both, a competent engineer, a man that knows his business, is as essential for a gas engine installation as for a steam plant.

Another line in which much has been accomplished, and in which there may be a chance for improvement, is in the proper water circulation, especially for large units. We recognize why large cylinders are more difficult to lubricate as they grow in size, but it is only within the past few years that the more exact principles of the transfer of heat have been defined, and on this rests the evident remedy, if our dimensions keep increasing.

In some circumstances, such as where illuminating gas is available, it would be a boon if we could still further increase the fuel economy of these engines; they are high now, but should be still higher, and I believe that the relief will come, and come this time from the theoretical side of the profession. We need more data, complete data, showing in detail where and why the heat is distributed through various losses, and anyone having information should publish it for the good of the trade. There is a possibility of further controlling the loss by cooling water once the correct theory of exchange is determined.

Another field that would welcome increased fuel economy, though all fields should be interested, is that of the aeroplanes, for this newest triumph in mechanics is largely a gas engine triumph; they do not get the credit of it, but it is true. Until a light, powerful, reliable engine was available man could not fly; now that he has tried his new wings, has conquered the air and learned to balance himself twixt earth and sky, the hope and dependence for improvement is still the gas engine—he must fly farther, and to fly farther he must, as he can carry no more fuel, have a more economical engine. And he will get it, for the gas engine designer will give it to him. But how? By theory and practice, advancing hand in hand; each with a shoulder to the revolving riddle, this is the team. Sound practice and intelligent theory, that will lead in the procession for commercial success.

*Abstract of paper read at the National Gas and Gasoline Trades Association meeting.

GAS ENGINES—THEIR ADAPTABILITY*

By W. M. Hampton

A FEW years ago when the blast furnace men began to use gas under their boilers and cut out the coal they imagined they had reached the height of achievement of blast furnace gas. Today, almost entirely, we are using gas engines for the production of power at Gary and the gas engine has been in a large measure bought by other companies belonging to the United States Steel Corporation. The Pennsylvania Steel Company, at Lebanon, Pa., is using gas from a bi-product oven. They pipe that gas 6 miles and use it in gas engines for the production of electric power.

A Philadelphia company uses a waste product which was formerly burned under boilers and are distilling a gas from the light distillate or refuse of the refiner. It is operating its power houses, and all electrical power is generated from this light distillate in gas engines. The bi-product ovens furnish gas for gas engines and are doing fine work. It brings us back to the subject of blast furnace gases, which formerly was largely wasted.

As I said a little while ago, the highest achievement several years ago was burning it under the boilers for steam. A little more than 2 or 3 yr. ago the United States Steel Corporation went into the subject of gas engines very extensively, and the result was that upwards of 200,000 hp. were bought to go among their different plants. We have today at Gary 33 3,000 hp. gas engines, 99,000 hp. We have a large portion of them in operation, some are put into operation every day. We are furnishing all the electrical power that is used in the manufacture of the rails and billets and are supplying the town of Gary and small concerns through the town with commercial current from these gas engines. We have only 2 2,000 kw. steam turbines, which comprises the whole steam plant.

Some of our old engineers 15 or 20 yr. ago, if we had said that we could get over 750 to 800 ft. of piston speed, would have put us in the insane asylum, but now they have attained 1,000, 1,300 and 1,500 ft. piston speed.

The cylinders we have at Gary are 44 by 54, 83 to 84 r.p.m. and get theoretically 200 lb. compression, actually about 185 lb. They are horizontal, twin tandem, double acting engines. These engines are undoubtedly an absolute success, so much so that they run 30 days with 25 min. shut down. The voltage varies about 2 per cent. It is not difficult to keep the pistons cool. We have ample cooling surfaces and find no trouble at all. The engines are running in parallel and we have no more trouble in getting them in step than you would have with any similar size steam engine. We start them up to speed and they go in on the line.

In all gas engines, irrespective of what make or style, you have a little cross current due to various

*Abstract of paper read before the National Gas and Gasoline Trades Association at its annual meeting.

causes, sometimes due to the igniters, to weak mixture, etc., but we do not get any more cross current than we would on any bad regulating steam engine. There is no more reason than there would be on a steam engine if properly looked after. The maintenance of a gas engine should not be any more than on a same size power in a steam engine. Of course, you must understand that a gas engine weighs more per horsepower than a steam engine, and the reciprocating parts are heavier. I am not prepared to say just how much depreciation you would have on such a plant in a year.

We have a magnetic make and break current, generated by motor generators at about 90 to 100 volts. Each engine takes about 1.5 to 2 amperes. On our blowing engines, in addition to our motor generator, we have floating on the line a small storage battery. It is a 16-ampere battery, good for about 4 hr., and will run 8 of our engines for 3 hr. or 6 for 4 hr., so that if the motor generator set goes out we do not know the difference. We must have our blowing engines absolutely reliable in ignition.

We have had no serious troubles there other than any other gas engine man has had. We have had all the troubles any gas engine man has had. We have had varied troubles, like bad ignition, bad gas, etc., but aside from that we have had nothing serious.

LONDON LETTER

THE HUMPHREY GAS PUMP

By W. A. Tookey

DURING the last month the long promised particulars of a new gas motor have been published by a number of technical journals on this side, and the novel features embodied in the simple scheme of operations are worth a little study.

The inventor, H. A. Humphrey, is well-known as an expert on large gas engines, having acted as consulting engineer to Messrs. Brunner Mond & Co., the large chemical manufacturers at Northwich, the South Staffordshire Gas Co., of Dudley Port, and many other users of gas engines of large power. In the course of the last 2 yr. he has repeatedly made reference, during discussions on various papers before technical institutions, to the new gas motor which he had in process of construction and experiment, but, apart from information of a general character, no details have hitherto been published on account of the unavoidable delays in connection with patenting the device in various countries. It is interesting to know that his application for patent rights has been granted in all countries without question, and this in itself is an admission that the motor is of novel design.

Briefly stated, the apparatus consists of a length of pipe of suitable diameter terminating in 2 vertical ends or legs—one shorter than the other. The shorter one is connected to a suction chamber in such a manner that the water can flow in through the valves under the influence of a slight head. The longer leg is connected to a reservoir at the required height above the pump.

Assuming the pump to have been started, the sequence of the operations is as follows: A charge of gas and air entrapped in the space C in Fig. 1, is under compression, and is fired by an electric spark. This sets in motion the water in the long U leg, and by its motion the water acquires a momentum so great that it continues to flow after the pressure of the exploded gases has been reduced to that of the atmosphere. The continued movement of the water permits the suction valves to open, and thereupon a fresh quantity is brought into the system, a part of which follows the movement of the main body of water, whilst a portion rises within the combustion chamber in the endeavor to keep the water-level inside this chamber the same as that in the suction tank.

At this period, there is, in fact, a slight vacuum inside the compression chamber, so that air enters at the top through a special automatic scavenger valve, while the exhaust valve also opens under the influence of such vacuum. In this way, the whole of the space in the vessel above the water in the short U leg is filled with pure air. As soon as the movement in the one direction has expended the acquired momentum, it begins to flow back under the static head due to the position of the delivery tank, since the pressure in the combustion chamber at this time equals that of the atmosphere, so that the water which has been drawn into the system from the suction tank is then forced backwards towards the combustion chamber. The backward flow expels all spent gases through the exhaust valve which then closes, a locking bar coming automatically into operation to prevent its reopening until the appointed time.

The momentum acquired during this backward movement compresses the air entrapped in the chamber C to a pressure considerably in excess of that cor-

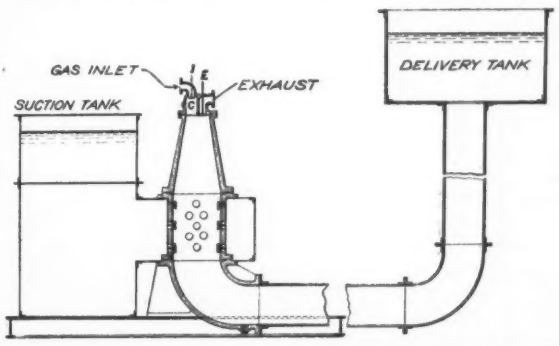


FIG. 1.—SECTIONAL VIEW OF HUMPHREY GAS PUMP

responding to the static head, the result being that once more the flow of water is reversed and fresh momentum acquired which causes the pressure in the combustion chamber to once more fall below that of the atmosphere. At this moment the inlet valve opens and a charge of gas and air is drawn in as the column of water continues to flow outwards.

As soon as the forward momentum has been again expended, the water once more flows back into the combustion chamber, compressing the charge previously admitted to a higher pressure than that due to static head, and when the desired compression is obtained the mixture is ignited electrically and a further cycle of operations is begun.

It will be noticed that the ordinary Otto cycle is thus followed out, but that there is (1) a long expansion stroke; (2) a long return stroke, during which the products of combustion are expelled; (3) a short stroke

during which the fresh charge is drawn in; and (4) a short compression stroke completes the cycle.

The efficiency attained is remarkable, and at low lifts exceeds that theoretically possible were the cycle identical with that used in the ordinary Otto engines. This economy, in the main, is possibly due to the utilization of the toe of the indicator diagram, which, in the ordinary engine is of course wasted since the exhaust valve opens when the gases are at 30 to 40 lb. above atmospheric pressure. The only moving parts are the light automatic valve, which, during the course of experiments has run for a week at a time without lubrication, and the small spring-loaded piston which times the ignition.

Valve Operation

Seeing that the outward movement of the column of water induces a negative pressure within the combustion chamber, it is of course necessary to find some means whereby both the inlet and exhaust valves are prevented from opening simultaneously, and this is arranged by a simple inter-locking gear illustrated in Figs. 2 and 3. The locking bar lettered A slides to and fro between the 2 valve stems under the influence of the springs B and C, which are alternately set in tension by the motion of the rocking lever D below. This frame is rocked alternately one way or the other by the projecting collars EE mounted on the valve stems.

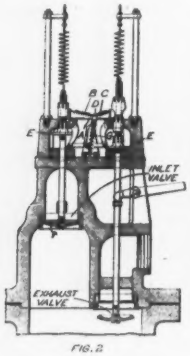


FIG. 2

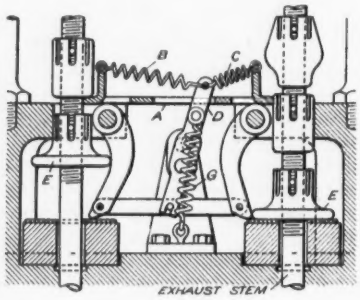


FIG. 3

FIG. 2.—INTERLOCKING VALVE GEAR
FIG. 3.—DETAIL OF INTERLOCKING VALVE GEAR

In Fig. 2, the appartus is represented with the exhaust valve open. In the descent of this valve, the collar E is forced over the rocking lever D, and once the latter has passed its center, it is held in that position by the spring G as shown, thereby putting the spring B in tension so that the locking bar A tends to move to the right from under the screw collar on the admission valve stem. It cannot, however, escape from under this collar until the exhaust valve has returned to its seat and has thus taken away the stop formed by the upper collar on the exhaust valve stem, but, as soon as this valve has returned, the spring B moves the locking bar over, so as to come under the collar on the exhaust valve stem, and thus retains it in its closed position.

It will be seen that the locking of the one valve unlocks the other, so that when a partial vacuum is again established in the combustion chamber, due to the moving column of water, the inlet valve alone is able to open under the influence of the suction this caused. In the descent of the valve, it shifts the locking lever D over to the other side of its center of oscillation, the spring D once more holding it in its position. At this time the spring C is in tension and thus tends to unlock the exhaust valve stem, which of course cannot move until the admission valve has been brought to its seat, allowing the locking bar A to move over to the left.

Ignition Device

The ignition gear consists essentially of a spring loaded piston, the spring being in the form of tongs. The piston rod passes between 2 friction wheels just above the circular base-plate, and these wheels are pressed into contact with the rod by springs. As the rod rises, therefore, the wheels rotate.

Affixed to one of the wheels by a friction grip, is a small contact-making lever, the mark of oscillation of which is limited by stops, and thus while the pressure inside the combustion chamber acting upon the piston moves the rod upwards, the contact lever is pressed against its lower stop. The instant, however, the pressure has reached its maximum and begins to diminish again, the contact making lever is flung over against its upper stop and fires the charge. An alternative adjustment is provided by means of which the ignition is timed to occur as soon as the compression reaches a pre-determined value.

The starting of the plant is quite a simple operation. After an ordinary stop, made by switching off the ignition current, the combustion chamber is left with a charge of gas and air inside it, and the pump is then restarted merely by igniting this. In the case of first setting to work, the starting operation is almost equally simple. Compressed air is forced into the combustion chamber so as to lower the water-level to about that of the suction tank. The exhaust valve is then thrown open by hand and the rising water column in the water chamber compresses the air entrapped there, then moves back again, drawing in a charge which is afterwards compressed and fired in the ordinary way.

Results of Tests

Particulars are given of a test of a gas pump of this description at Dudley Port at the works of the South Staffordshire Mond Gas Co., by Prof. W. C. Unwin, from which it appears that a small plant giving 16.15 pump hp., and lifting 1,621 gal. of water per inch a height of 32.9 ft., has worked with a coal consumption of only 1.06 lb. pump hp. hour. This fuel ecomony is striking and is unequalled by any other pumping arrangements.

LIMITATIONS TO ROPE DRIVE

Where large amounts of power are to be transmitted the selection of rope drive is only limited by the allowable distance between shafting journals. A number of drives of 4,000 hp. are running with the best of satisfaction, while systems of from 1,000 to 2,000 hp. are numerous. It is claimed by the Plymouth Cordage Co. that in drives of such magnitude rope has a considerable advantage over leather belting, not only in first cost but in safety.

In the matter of first cost no comparison can be made above 1,000 hp., and where centers of driving and driven shafts are nearer together than 25 ft. or farther apart than 35 ft., the rope is decidedly superior to leather with smaller powers. The first cost of leather in a belt drive, assuming the most favorable conditions for it, would be about 2.5 times the cost of manila rope to transmit equal power.

The cost of the pulleys in a rope drive would be about ⅓ more than the leather-belt pulleys, which, in a drive of large capacity, would leave a good margin in favor of rope. This margin increases rapidly in favor of the rope as the distance apart of shafts or amount of power transmitted increases. The matter of first cost may be carefully estimated in each particular drive and the comparative sum closely ascertained.

ABSORPTION REFRIGERATING MACHINES*

By Henry Torrance, Jr.

REFRIGERATING machines generally produce cold by the evaporation of ammonia, although other kinds of machines have been used, including ether machines. If you heat ammonia in a closed vessel the pressure will rise in direct proportion to the rising temperature, and at about 150 lb. per sq. in. the temperature is about 80 deg. F.; if you know the pressure, you can tell what temperature you have.

If you have some liquid ammonia under pressure and release the pressure it starts to evaporate and produces the cooling effect. To get the pressure to condense the ammonia gas, aqua ammonia is put in a boiler and by circulating steam through the coils the ammonia is heated the same as boiler flues heat water. As the temperature rises the pressure also rises and the gas is driven off and passes into the condensor. The temperature of the condenser regulates the pressure which rises until the condensing of the ammonia limits it. The gas will expand from the condenser

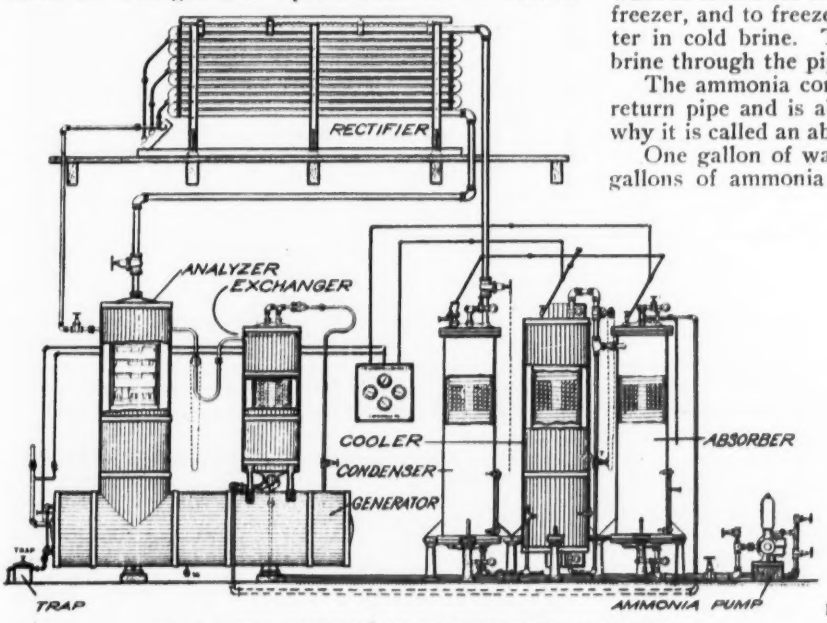


FIG. 1.—THE CARBONDALE REFRIGERATING MACHINE

where the pressure is about 150 lb. into the cooler where you let it drop to 15 lb.; a certain portion evaporates immediately, and for every pound that evaporates you absorb about 550 B.t.u., which cools the brine circulating in the pipes.

Cooling effect starts at the expansion valve; on one side the pressure is 150 lb. and on the other 15 lb. When the liquid passes the valve into the cooler at 15 lb. pressure, a portion of it evaporates on the instant. I really think a portion evaporates instantaneously cooling the rest of the ammonia down to the temperature of the cooler. The brine passing through these coils is cooled by the ammonia that is evaporating in the cylinder outside the coils.

It is an interesting fact that if you should pump the brine through the cylinder and expand the ammonia through the coils, you would not get more than 0.1 the efficiency, for the circulation of brine in these coils is like putting your hand in water and stirring it up. Where you have a cooler of this type with the brine circulating through the coils and the ammonia on the outside, you can get splendid results with 12 sq. ft. of heating surface per ton. If you put the ammonia in the coils and the brine in the cylinder or tank you need 50 sq. ft. per ton and even that won't do nearly as well.

The first brine coolers were built in England by Pontifex over 30 yr. ago. The common practice was and has been to use expansion coils. Pontifex may have started building brine coolers knowing that it was a better design, but I think it was simply a happy chance and that he designed better than he thought. It was not until 1892 that this cooler was first put on a compression machine, which was in Cleveland, Ohio, for the Standard Oil Co.

In an ice machine you want cold brine. If you want to freeze ice cream you put the brine around the freezer, and to freeze ice you submerge the can of water in cold brine. To cool a room you run the cold brine through the pipes.

The ammonia comes out of the cooler through the return pipe and is absorbed in the absorber. That is why it is called an absorption machine.

One gallon of water will absorb about a thousand gallons of ammonia gas which shows the enormous

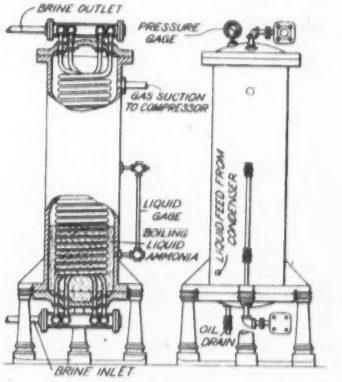


FIG. 3.—CROSS SECTION AND EXTERNAL VIEW OF A BRINE COOLER

contraction in volume. The gas to the absorber flows through the return pipe and meets a spray of liquid which picks it up, heats it a little and falls to the bottom, constantly being cooled by the water coils and absorbing more gas as it falls.

The figure in the corner of the diagram is supposed to be a pump which pumps the ammonia solution or strong liquor as it is called from the absorber back to the generator. The absorber is like a jet steam condenser, the only difference being that in a steam condenser the water of condensation supplies the cooling effect. In an absorption ice machine the liquor is not cool enough to absorb the gas and you must have cooling coils to overcome the heat of absorption and keep the mixture cool. When you mix steam and water in a jet condenser it does not take much time, but in the absorber it takes time to transfer heat from the cooling coils to the liquor, hence an absorber is much harder to correctly design than a steam condenser.

*Lecture delivered before the Modern Science Club.

You can run absorption ice machines with exhaust steam at 1 to 3 lb. pressure, or without any pressure if you can get the steam through the coils, but for peace of mind it is better to have a few pounds pressure.

The exchanger is to heat the cold liquor which comes from the absorber before going into the generator. The cool liquor flows through the suction pipe to the ammonia pump. The hot liquor passes out through the weak liquor pipe, from the bottom of the generator, and passes up through the exchanger the opposite way to the absorber. The temperature of the hot liquor in the generator may be 230 deg. The temperature of the absorber is about 100 deg.

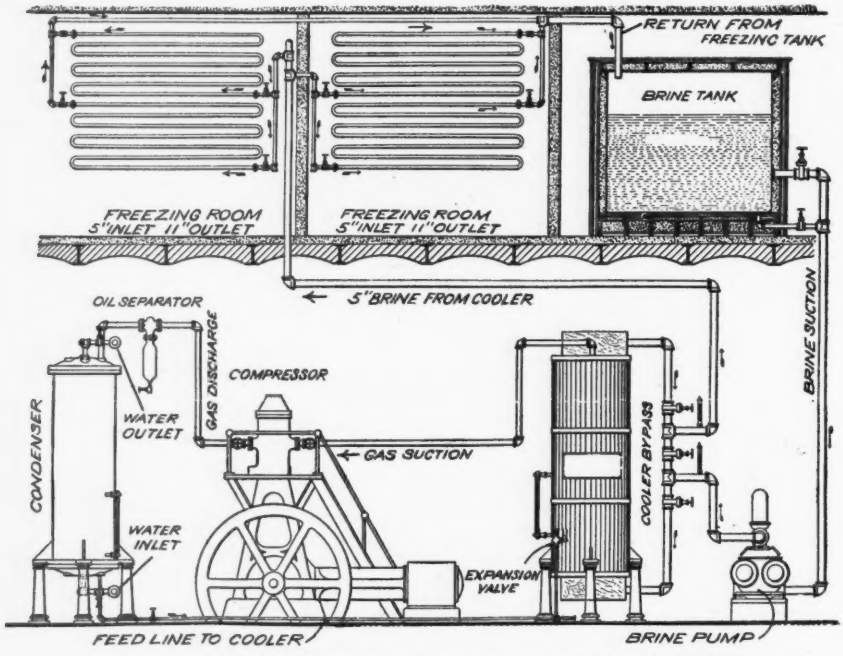


FIG. 2.—HENDRICK BRINE COOLER AND AMMONIA CONDENSER

In the exchanger it does not make much difference which liquor flows on the outside, as the solution is about the same in each case, but in the brine cooler you have gas evaporating on one side and brine on the other.

The transmission of heat between 2 liquors is much faster than between a gas and a liquor.

Figure 2 shows a compression machine, in which you have a piston which sucks gas from the cooler as the piston comes down, and when it goes up it compresses the gas into the condenser. In a compression machine you have 3 things; a compressor driven by an engine, a cooler and a condenser.

With this compression machine if you expand the ammonia in expansion coils submerged in a tank of brine, the tank would have to be many times the size of the brine cooler.

Figure 3 shows the inside construction of a cooler. You can see how the coils are wound in the inside. The brine flows through the coils. In the condenser the water flows through these coils.

The spray arrangement in the absorber is shown in Fig. 4. The liquor sprays through the nozzle and falls on a perforated plate and then splashes down over the cooling coils constantly absorbing ammonia.

A system in which air is cooled by blowing it over brine coils is shown in Fig. 5. If you circulate air over pipes the velocity of the air increases the efficiency exceedingly. When you have a cold brine pipe and can circulate air over it you can do far more with the same pipe than if the air were lying still, and if you should pump water over them to cool the water the efficiency would increase enormously. A brine cooler 4 by 10 ft. and containing a thousand square feet would cool a cold storage house of 500,000 cu. ft. having 25,000 sq. ft. of brine pipe surface.

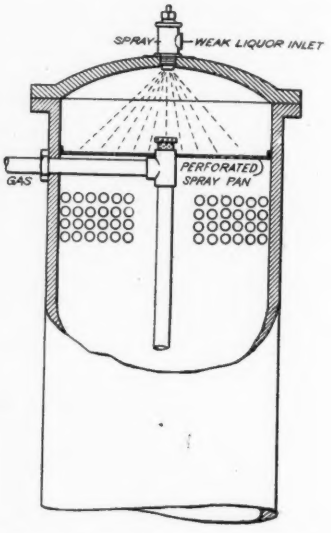


FIG. 4.—SECTION OF ABSORBER SHOWING SPRAY

In a plate ice tank, the cold plate freezes the ice on each side, and after it has been freezing for 7 days, it is about 12 in. thick. With cold brine in the plates you can get 5 in. of ice in 24 hr. We generally figure about 10 in. in 4 days and 13 in. in 6 days.

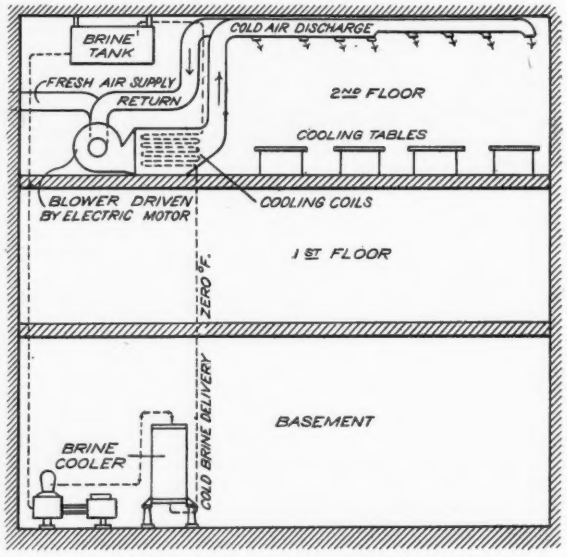


FIG. 5.—AIR COOLING SYSTEM

BLOWING OUT CONDENSER PIPES WITH STEAM

We have a 10-ton ice plant in connection with our light plant. The ice plant has been run 6 yr. without having the coils and condenser blown out. As we have no air pressure to blow the coils often we must blow them with steam. Will there be enough heat in the pipe to take up the moisture after blowing with steam, and what effect will the steam have on the joints made up with lead gaskets and glycerine, and lead oxide or litharge? Would you recommend pumping gasoline through the coils to clean them, do you think it would loosen up the joints? C. E. McN.

Your description is not very clear as you failed to state by which system the plant is operated, but presume it is a compression machine. You say the plant has been operated for 6 yr. without having the coils and condenser blown out but as you do not state which coils, we presume you mean the inner pipes of a standard double pipe type ammonia condenser, as they are frequently called coils. To clean these inner coils or pipes where the water passes through, make a steam connection to each coil separately at the top, of course making a free outlet at the bottom, and blow one coil at a time; the steam pressure will effectually remove all matter adhering to the internal portion of the inner pipes, then follow with water pressure, in the meantime see that the extra heat from the steam does not materially increase the ammonia pressure.

This will no doubt increase the temperature of the liquid ammonia at the expansion valve, and if this cleansing is done while the machine is in operation, it may be advisable to blow only one stand of coils each day because an increase in temperature of the liquid ammonia from 5 to 8 deg. will materially affect the output by reason of the expanded gas being unable to absorb the same number of heat units as before.

The steam will have no effect on the joints mentioned, but the valve should be opened gradually until steam appears at the outlet, in order to avoid irregular expansion of the pipes. We have never used gasoline for the purpose mentioned, but as it is very penetrating we should consider it injurious to joints where glycerine or litharge is used.

The question of moisture needs no consideration in connection with the method described pertaining to ammonia condensers, but if by moisture, as mentioned in your letter, reference is had to the expansion coils in the brine tank, then it is essential that all should be expelled or evaporated, and if they have not been cleaned in 6 yr. they should have a thorough treatment, first by removing the brine and then examining all the coils, see that they have proper drainage and no kinks to form a trap, then the method described for blowing out the condenser coils will apply in this case also, unless it is done during cold weather when water cannot be used for fear of freezing.

In addition however to cleaning they should be tested to not less than 300 lb. pressure, and for testing purposes use brine because it will not freeze and decrease the area of the pipes.

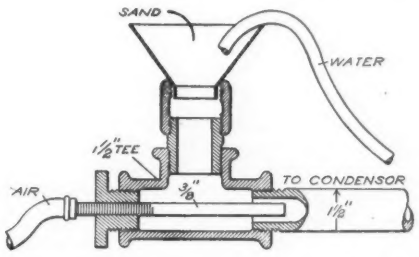
This work should be done expeditiously in order to get the coils again submerged in the brine and avoid deterioration by long exposure to the atmosphere.

W. S. Luckenbach.

CLEANING CONDENSER PIPES

At overhauling time one engineer decided that he would like to clean the double-pipe condenser without having to remove all the return bends, a tedious and time-killing process. The condenser had been thoroughly coated with a lime and iron deposit from the well water in use and was badly in need of cleaning.

The solution of the difficulty presented itself when it occurred to him to scour out the pipe with compressed air, using a mixture of sand and water under 20 lb. pressure. The device which he used to do the work is shown in the accompanying drawing.—Ice.



SAND AND WATER CONDENSER PIPE CLEANER

HOW TO MAKE SOLDERING PASTE

Soldering paste has now come into extensive use in electrical work as a flux for soldering. This has been brought about by the requirements of the electrical trade that in certain forms of soldering no acid shall be used. For soldering copper wires for electrical conductors, soldering paste is used almost exclusively. It has also entered other fields of soldering, particularly in instances where spattering and corrosion are objectionable.

Soldering paste, which is now used in the electrical trades, consists of a mixture of a grease and chloride of zinc. The grease which is commonly used is a petroleum residue, such as vaseline or petrolatum. Such a material is about right in consistency. The proportions which are used are as follows:

Petrolatum .....1 lb.
Saturated solution chloride of zinc.....1 oz. (fluid)

The use of petrolatum instead of vaseline is recommended. While they are identical in composition, the name "vaseline" is registered as a trademark and commands a higher price on this account. Petrolatum is much cheaper.

The chloride of zinc solution is made by dissolving as much zinc in strong muriatic acid as it will take up. An excess of zinc should be present and all the acid neutralized. This will form a thick, oily solution. The petrolatum and chloride of zinc are mixed and thoroughly incorporated by means of a mortar and pestle or by vigorous stirring.

The advantage of this soldering paste lies in the fact that it does not spatter and is not corrosive. It will be found excellent and is now extensively used.—Brass World.

TENSILE STRENGTH OF LONGITUDINAL stays, angles, and tee bars for boilers should be between 27 and 32 tons per sq. in. with elongation not less than 20 per cent. Bars for combustion chamber stays, 26 to 32 tons, with elongation not less than 23 per cent measured on standard test piece; but when bars are tested on the gage length of 4 times the diameter, the elongation should be 24 and 28 per cent, respectively.

WHERE LUBRICATION IS COPIOUS and speed not excessive, 50 lb. per square inch pressure on the crosshead slides and guide blocks may be allowed.

THE HARRIMAN ROTARY ENGINE

BALANCED STEAM VALVE TO SECURE EXPANSION

THIS engine, which is the design of J. E. Harriman, Jr., is a cross between the reciprocating and the turbine engines. It has a straight shaft, a cylindrical casing, and the piston has a mechanical rotary motion within the casing, but power is delivered as in reciprocating engines by bringing steam in a tight chamber against a piston instead of by unrestricted expansion or impact of a jet of steam.

These engines are well balanced, and may be built of any power with any number of rotors on the same straight shaft; the piston speed will be much greater than for the reciprocating engine, but is slower than the turbine, so that no reduction gearing is needed. The high piston speed reduces the big initial condensation as well as increasing the power.

Balancing

As shown in the detail, the piston is cylindrical, and is attached to the shaft, the weight being counterbalanced by the removal of an equal amount of weight, one-half taken from the flywheel on one side of the engine, and one-half from the flange wheels, which connect the shafts of the 2 engines, which are mounted on the same base. The shaft of the engine centers in the cylinder, and the cylindrical rotor travels around in the cylinder, fitting the casing within 0.001 in.

Leakage of steam is prevented, as is also friction, by a novel design of packing ring, consisting of 1 ring within another, the 2 pressing at right angles to each other, and thus closing every space through which the steam might pass. In order to cut down friction in the ring, the rotor is drilled with holes through the overhang, and these connect depressions on each end of the rotor, so that any steam leaking through balances the pressure on the 2 sides of the piston.

Steam Distribution

Separation of the steam from the exhaust side of the cylinder is made by a hammer shaped abutment which rides on the periphery of the piston. This is pivoted at one end by a hollow bearing in the side of the casing, and is held against the rotor by means of a steam piston at the back, and steam pressure. Provision is made for rising and falling of the saddle, which forms the partition between steam and exhaust chambers while at the same time keeping this saddle steam tight against the rotor.

Steam is admitted once in each revolution by a piston valve with holes drilled through it, operated by an eccentric which is attached to the main shaft outside the main bearing. Steam ports are provided near the front edge of the piston valve, and the holes pass clear through the plunge so that it has a free movement while in operation. Steam surrounds the entire casing of the engine, thus cutting down the condensation.

Just as the protecting part of the rotor reaches the lower side of the admission port, steam enters the steam chamber through the valve, as indicated by the arrow. The steam cannot pass to the exhaust chamber as the hammer shaped partition has a recessed joint with the saddle bearing on the rotor, hence it forces the rotor around until steam is cut off when the rotor piston is half way to the exhaust chamber.

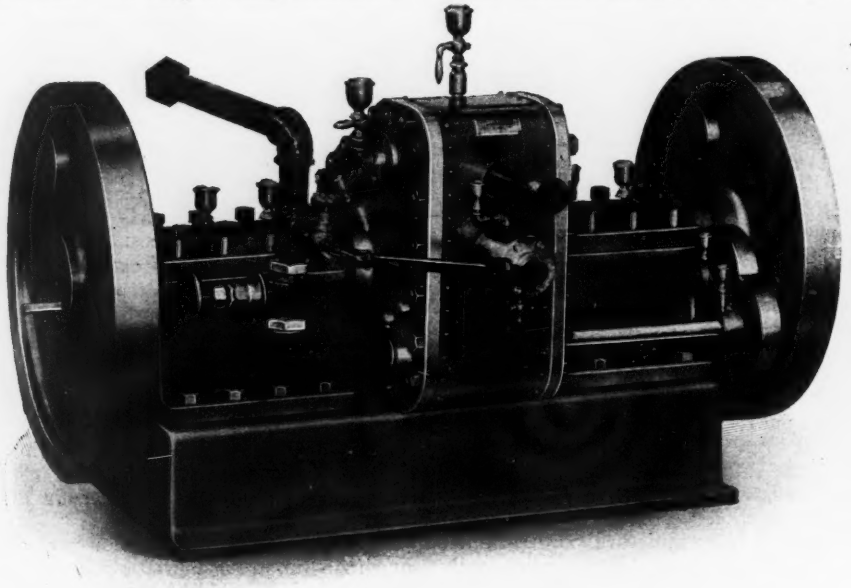


FIG. 1.—HARRIMAN ROTARY STEAM ENGINE, SINGLE ROTOR

From that point on, expansion of steam drives the piston until it reaches the edge of the exhaust chamber when the steam is thrown into that chamber, and escapes through the exhaust pipe up the casing. Study of the steam pressure will show that it acts as a wedge shaped volume against the rotor, under and around the shaft, thus carrying the weight of the shaft and rotor, and pressing the shaft upward against the top of the main bearing, helping in the matter of lubrication as well as cutting down the wear on the bearings.

Compounding

It is evident from this that the action in the steam cylinder is the same as in a reciprocating engine and the cylinders may be compounded exactly as with a

reciprocating system. In the case of a compound engine, the 2 cylinders are mounted on a single heavy base with the pistons on the same shaft, and the 2 engines are constructed entirely independent of each other. Connections for steam and exhaust are so made that the engines may be run as a compound engine, or with live steam entering both cylinders, or the flange disconncted and the high-pressure running alone, or the low-pressure running alone, or the flange disconnected running the high-pressure engine at one speed exhausting into the low-pressure engine which runs at a different speed.

Tests

Tests made of this engine at the Massachusetts Institute of Technology in October, 1908, showed a steam consumption when running without condenser but with expansion of 79.8 lb. of steam per horsepower-hour at 2.85 hp.; and of 58.26 lb. per horsepower-hour at 3.87 hp., when running condensing, with 25.5 in. vacuum. The pressure in both cases was 125 lb. and the speed for the noncondensing test 434 r.p.m., and for the condensing test 522.

Tests made with superheated steam showed that at 126 lb. pressure and with 93.7 degrees superheat, with a vacuum of 23.7 in. the steam used was 41.24 lb. per horsepower-hour at 5.4 hp.; speed was 565 r.p.m. Tests on a larger engine recently made at the Massachusetts Institute show with an average gage pressure of 140 lb. and r.p.m. 473, a brake horsepower of 23.4, and steam per brake horsepower 38.9 lb. These tests were made with vacuum in the condenser, but the amount is not given. Another engine tested at Massachusetts Institute was run by gas and operated exactly in the same way as the steam engine, except that the motive fluid was gas at a high temperature and pressure instead of steam.

It is interesting to note that the development of this engine came about as the result of the studying of requirements of flying machines for motive power, Mr. Harriman having taken out a number of patents for flying machines, and having studied the matter of motors for application to them. The dimensions of the little engine tested at the Institute were small and the horsepower running compound was 5.4 and with high-pressure steam on both rotors 8.9 the rotor 9.4 in. diameter and 8 in. long, revolving in a 12 in. case, and having a shaft 4 in. in diameter. This runs in bearings 13 in. long by 3.25 in. in diameter, each bearing containing a gallon of oil. The engine makes 300 to 600 r.p.m. and develops 15 to 25 hp. In this latest design steam admission is accomplished by means of a rotary valve instead of a reciprocating valve, thus simplifying the design, and doing away with all reciprocating parts.

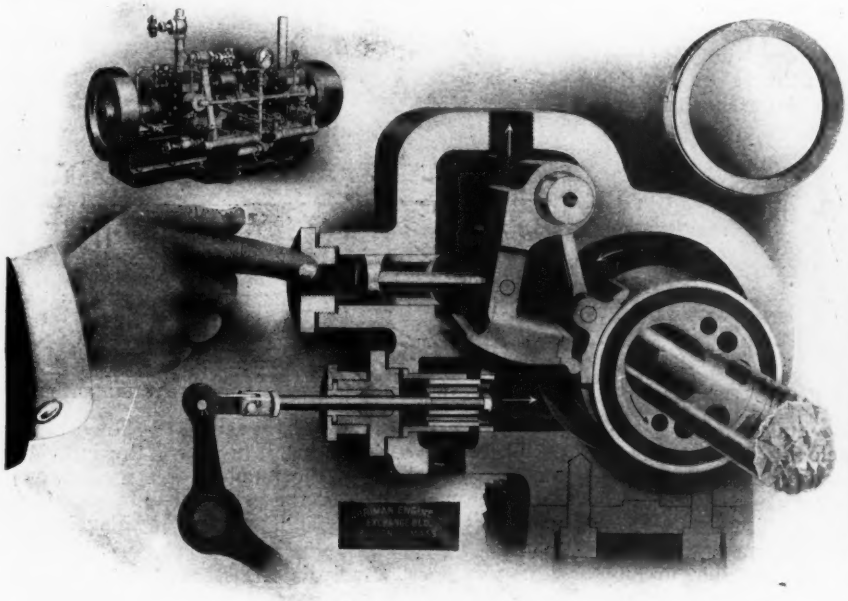


FIG. 2.—DETAILS OF HARRIMAN ROTARY ENGINE

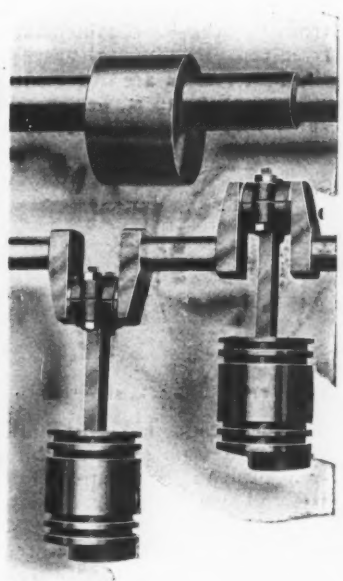


FIG. 3.—COMPARISON OF ROTARY AND RECIPROCATING ENGINE SHAFTS

GETTING A LIBRARY OF TECHNICAL INFORMATION WITHOUT COST

Literature issued by the leading manufacturers of power plant machinery and appliances contains a tremendous amount of technical information bearing on the installation and most economical use of such products. It deals with modern practice—with today's ways of doing things—and much of it is of positive educational value to the man responsible for "keeping the wheels going 'round." In fact some of the catalogs and bulletins circulated by these companies are veritable text books on the subjects treated.

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CENTRIFUGAL PUMPS

THEIR TYPES AND USES

THERE are 2 types of impellers employed in centrifugal pumps, these being designated as enclosed and open. The open impeller has only a limited application, and it finds its best field in low lift pumps of single stage type; its efficiency even here is so much less than the enclosed type, that in most cases it can hardly be recommended. There are, however, certain classes of rough work, such as are met in contracting, where the open impeller pump presents the best solution.

Both general types of impellers are shown in Fig. 1, in which it will be noted that on the open type the walls A and B are lacking. In the design of centrifugal pumps many interesting problems are presented, and the majority of data for these designs are secured from the results obtained on the test floor. Results from tests made upon centrifugal pumps indicate that the best results are obtained when the velocity of the water is 8 to 10 ft. per second in the casing through the pump. This velocity may be increased for high

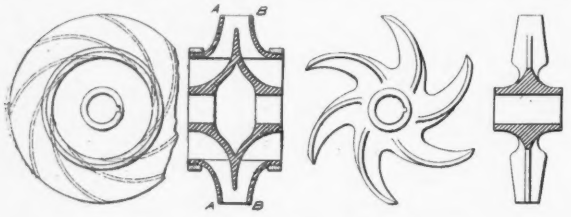


FIG. 1. ENCLOSED AND OPEN TYPE IMPELLERS

lifts per stage, but within these limits the best efficiencies are obtained as this velocity in itself determines the size of pumps to be used for a certain capacity, and also the range of adaptability of a given pump casing.

There is a limit therefore, to the amount of work that can be performed by a single impeller, and by experience it has been proved that it is inadvisable to design a single impeller for a lift of more than 140 ft. Above this height it is considered best to use pumps with 2, 3, 4 or more impellers, upon the same shaft.

In Fig. 2 is shown the cross-section of a general type of single suction centrifugal pump. The water enters the pump casing at A and is drawn into the impeller B, where it is caught by the blades and discharged into the water chamber C, which conducts it to the outlet. The energy transmitted by the impeller to the water is partly in the form of hydro-static pressure, and partly in the form of velocity, the percentage of each depending on the form of the individual blade. The passages through the impeller and casing should be smooth and clean so as to reduce the friction losses and increase the efficiency of the pump.

In order to prevent leakage, the impeller has mounted upon it 2 rings, E and H. It will be noted that the impeller maintains a pressure in F and a suction at B which tends to draw water between the ring E and the casing. The ring E is therefore introduced to prevent this leakage. On the other side the ring H is mounted on the impeller to help balance it against the end thrust.

In the single-suction type of impeller there is a force due to the impact of the water against the impeller, which tends to drive the impeller in the direction of the shaft. This is overcome by drilling a number of holes as shown at I, through the disk of the impeller. These are so drilled that the pressure in the chamber J is about the same as the suction pressure. By these means the pressures existing inside these rings results in a perfect balance.

In the double suction type of pump, the water being drawn from both sides, it is not necessary to employ any means of balancing the impeller. As with the single suction impeller, this type is also satisfactory for heads up to 140 ft., and is particularly adapted for use with steam turbines, due to the high speed which is available.

Lifts from 140 to 150 ft. are best accomplished with centrifugal pumps by employing 2 or more impellers

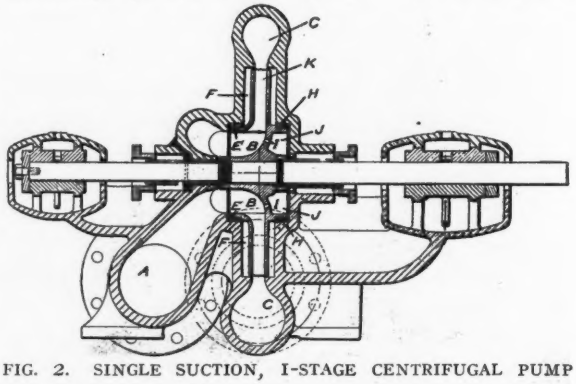


FIG. 2. SINGLE SUCTION, I-STAGE CENTRIFUGAL PUMP

placed upon the same shaft in series, as shown in Fig. 3. The same construction is used for the individual impeller regardless of the number of stages through which the water passes, the principal difference being in the form of casing and manner of balancing the pump.

Analysis of Losses

The losses which are encountered in centrifugal pumps may be classified under 3 heads: Pure mechanical losses, hydraulic losses, and leakage losses. Besides that due to the friction of bearings and stuffing boxes, the principal loss is energy expended in the rapid movement of the impeller through the surrounding waters, even though the surfaces of the impellers are highly polished. Although this loss has never been calculated definitely, it has been proved that it increases with the square of the number of revolutions, and with the fifth power of the diameter. For this reason it is better to run small disks rapidly than large ones slowly. It is most convenient, therefore, to use electrical driving such as high speed induction motors. This peculiarity of the rotary friction loss is decisive also in fixing the number of stages to employ.

Hydraulic Losses

The hydraulic losses are complicated and difficult to calculate. As the water leaves the impeller blade after it has been accelerated, it takes the tangential velocity of the impeller. It is also given a relative velocity, as compared with the wheel, in the direction of the channels through the impeller. This relative speed depends upon the cross-section of the channel and the quantity of water passing through it per sec-

ond. The direction coincides with the axis of the channel. Both are combined in the resultant absolute velocity. The tangential velocity and the cross-sections of the channels remain constant with the same wheel and the same number of revolutions, thus the value of the relative velocity alone changes, and that proportional to the quantity of water flowing through the pump.

From the hydraulic point of view the centrifugal pump works best if the flow of the water through the rotor and guide wheel is free from impact, both at the impeller entrance and outlet; that is, if the direction of the absolute velocity of the water coincides with the axis of the channels. Many of the latest types of high lift centrifugal pumps have guide blades to produce this result. The condition of impactless movement of the water consequently is fulfilled theoretically only for a single rate of discharge which is the rated capacity of the pump.

Some manufacturers prevent leakage of water outboard around the shaft at the discharge end of the pump or leakage of air into the suction side of the pump by packing glands, which in addition to packing material under pressure, have a central open part to which water under pressure is introduced, effectually preventing the entrance of air. Leakage of water around the shaft where it passes through the diaphragm separating the stages is prevented by a long bronze-lined water-packed joint in which there is no rubbing contact. To prevent leakage from the discharge back to the suction, in other than single-stage pumps, a labyrinth bearing, shown in Fig. 5, is frequently employed.

Efficiencies

Based upon horsepower input and horsepower output, the efficiency of centrifugal pumps vary with the size of the pump. With the smaller pumps, say 2 in., the efficiencies obtained are rather unreliable, but a good average is 45 per cent; but as the size of the pump increases the efficiency also increases, and a good average with an 8-in. pump varies from 68 to 70 per cent. Above this dimension the efficiency does not increase so rapidly.

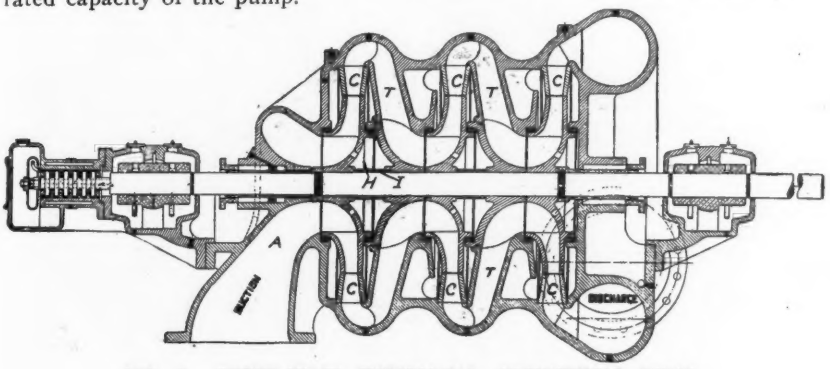


FIG. 3. THREE-STAGE HORIZONTAL CENTRIFUGAL PUMP

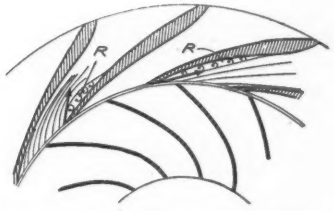


FIG. 4. RESULTS OF POOR DESIGN OF GUIDE BLADES

Some manufacturers have endeavored to construct centrifugal pumps with movable guide blades, but the mechanical requirements are such that as yet no marked success has been attained in this direction. Guide vanes of any design increase the amount of wetted surface in contact with water at high velocity. To give the best results they should be finely shaped and should terminate close to the impeller, which disposition, however, is found to result in rapid erosion of both guide vane and impeller blade tips, also in jamming and destruction of blades by solid substances carried in the water.

The assumption of radial inflow affords the best utilization of the available area, that is, a minimum inflow speed, maximum of allowable suction head, and similar advantages. This radial direction of inflow is attempted by some constructors by the use of special entrance blades.

It may be stated in general that guide blades must be designed with exceptional care, and many of the manufacturers have dispensed with them entirely, as they frequently create an area of whirling dead water, as indicated in Fig. 4, which is decidedly detrimental to best operation and efficiency. A similar phenomena may appear in the interior of the impeller when the blades are incorrectly shaped or the delivery differs considerably from the normal.

Leakage Losses.

The leakage losses, when they occur, are at the clearance between the impeller and guide wheel or water chamber casing, K, Fig. 2; between the chamber surrounding the impeller, F, and the entrance chamber to the impeller, B; and, in a multi-stage pump between the entrance to the next stage, T, Fig. 3, and the chamber surrounding the impeller, H, through I.

The advantages of the centrifugal design over the reciprocating type of pump for particular services are many. Comparing the 2 types it may be stated that the centrifugal pump costs about half as much and weighs one-third as much as the reciprocating pump designed for the same service. This proportion is greater and in favor of the centrifugal pump for lower head work, while for the higher head the cost of the 2 types are nearly coincident. For simplicity the centrifugal pump has a marked advantage over the reciprocating, as there are no valves or springs, and only 1 simple rotating element. The shafting is supported in ring oiled bearings, cutting down items of attendance.

Applications

This form of pump adapts itself readily to almost any method of driving employed around a power plant. It can be directly connected to any kind of motor or a steam turbine, and for low head to a reciprocating steam engine, gasoline or gas engine or a water turbine, or it can be driven by a belt or silent chain from a line shaft.

For use with barometric or jet condensers the centrifugal pump, driven by motor or steam turbine, is almost an ideal combination for central power station work. For this service the pump is arranged to deliver a smaller portion of water against a high head, after the vacuum is formed in the condenser cone, this head is reduced and the pump is designed to operate

economically at this running head with the delivery necessary. At both conditions of head the pump performs its service at constant speed.

It is for irrigation purposes, however, that the broadest field for the centrifugal pump is found. The volute pump, which is generally used in this service, will pump sandy water and is more economical than any other type. The capacity required ranges from 1,000 to 100,000 gal. a minute, and the heads are usually under 50 ft.

The peculiar advantages of the centrifugal pump for mine service are placing it far in advance of the reciprocating type. Due to the light weight of the parts in contact with the fluid handled, it is possible to construct the pump of non-corrosive metal when desired. When water handled is aciduous, as is often the case in mines, a good grade of acid resisting bronze is used, making it possible to build a durable pump at a moderate price. There are a large number of installations in mines where water is pumped against a head of 600 ft. by the use of multi-stage centrifugal pumps driven by electric motors, and the service performed is satisfactory from every standpoint.

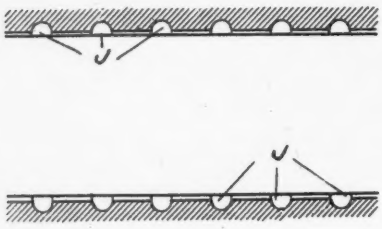


FIG. 5. LABYRINTH BEARING FOR CENTRIFUGAL PUMP

Boiler Feed Pumps

Perhaps the most interesting application of the centrifugal pump is that as a boiler feeder, driven by a steam turbine. The first requisite of a boiler feed pump is the ability to give uninterrupted service while receiving little attention. For this reason the simple direct-acting pump has long held the field, in spite of its many shortcomings such as an enormous steam consumption, tendency to produce shock and vibration, unsuitability for close regulation, numerous valves, etc.

The centrifugal boiler feeder, which has lately been taken up by several of the largest steam power plants in the United States, is free of these defects and possesses several important advantages in addition. It does not endanger the pipe line by vibration, by excessive pressure, nor by shock. The inflow of water can be regulated at the boiler without reference to the pump. A centrifugal boiler feed pump contains no valves and only 2 packings, of quite small diameter, to be kept tight against hot water. There is no danger of breakage of pistons, cylinder heads or packing rings through loss of suction and consequent pounding.

One thing that has retarded the introduction of the centrifugal boiler feed pump is the fact that it is not suited to reciprocating engine drive, as the comparatively low speed of the latter makes necessary a large number of stages in order to obtain the high heads required to overcome modern boiler pressure and if an attempt is made to keep down the number of stages by making the impeller large in diameter, the efficiency is seriously reduced. If, however, the pump is to be driven by a steam turbine or electric motor this becomes an advantage. For instance, the impellers of the 2-stage steam turbine driven pump shown in Fig. 6, designed to deliver 1,600 gal. a minute against a head of 700 ft. at 2,800 r. p. m., are quite moderate in diameter.

The impeller of this pump is of bronze, of a character found to resist the corrosive action of hot water, an important point since the least roughing or pitting of the impeller rapidly diminishes the efficiency of the pump. A further notable feature is the absence of guide vanes.

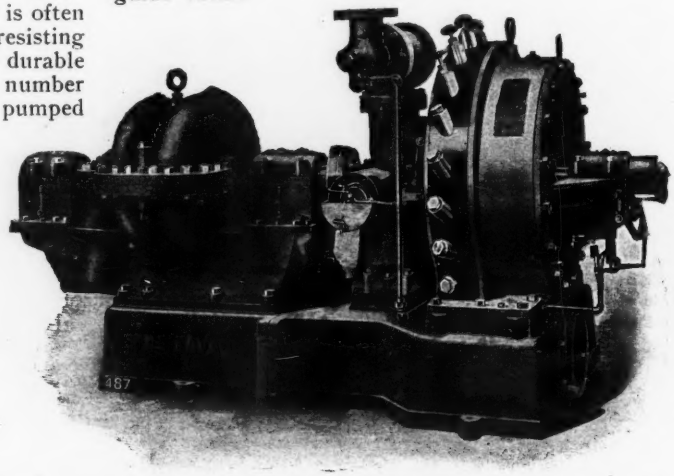


FIG. 6. TURBINE DRIVEN 2-STAGE CENTRIFUGAL BOILER FEED PUMP

Simplicity of construction and accessibility for inspection are essentials for any pump that is to be installed in a boiler room entrusted to unskilled labor. It should be possible to get at the working and wearing parts of a pump without disturbing pipe connections. As will be noted from the accompanying illustrations the casing of a centrifugal pump may consist of 2 parts only, the bottom casting and the cover casting. In the bottom casting are formed the inlet and outlet passages to the piping, while both castings contain passages leading from the delivery of the first impeller to the inlet of the second, these passages being cast in the solid metal.

While the impellers are in perfect hydraulic balance, one of the bearings is made of the marine thrust type in order to take care of any end thrust that might be developed by possible clogging of the balancing passages in the impellers.

The pump is directly driven through a flexible coupling by a steam turbine upon the same bed plate. The turbine is designed to receive steam at 200 lb. gage pressure with 150 deg. F. superheat and to exhaust into open heaters. The power for operating the pump therefore costs practically nothing, as all of the energy of the steam is returned to the boiler in the feed water, including even that expended as work and friction in the pump and turbine.

The governor of the turbine is an interesting feature. The pump can be controlled by an ordinary pump governor, of either the constant or excess-pressure type, inserted in the steam line ahead of the turbine, the turbine governor acting merely as a maximum speed limit. The turbine governor is driven by a worm gear from the shaft at a speed of 900 revolu-

tions per minute, making possible the use of a heavy, powerful construction. As an additional guarantee against excessive speed, an emergency governor is fitted to the end of the shaft. In case of overspeeding this governor trips a lever, which relieves steam pressure from under a piston controlling the emergency valve in the steam pipe outside of the turbine.

Where the amount of exhaust steam available in a plant is more than is required to heat the boiler-feed water up to 210 or 212 deg. F., turbines admit of being run with exhaust steam from other auxiliaries, exhausting into the main condenser, or they can be arranged for mixed flow, that is, with certain nozzles designed to receive live steam and others to receive exhaust steam.

When installing centrifugal pumps the size of the suction and discharge pipes should be such that the maximum velocity of the water will not exceed 200 ft. per minute, and the use of long sweep ells is recommended. Unless the suction water flows to the pump under head it is necessary to employ some method to secure primed condition, for the centrifugal pump will not take up its water under suction lift as is the case with other pumps. Every centrifugal pump is designed for certain duty, and if this head or duty is changed the result will be a loss of efficiency. It may be stated that in general for use with heads exceeding 700 ft., a reciprocating pump, built for that service, gives more economical results than the centrifugal pump.

BABBITT METALS

When we consider how important a factor Babbitt metal has become in relation to all mechanical matters, it is surprising that only 70 yr. have elapsed since it came into existence.

In 1839 when Isaac Babbitt secured a patent for lining journal boxes he little thought that he would become famous for all time through recommending the use of "Britania Metal" as a lining for his boxes, and that his patent would have practically been lost sight of, although he was presented with a gold medal by the State of Massachusets and Congress voted him $20,000.

Undoubtedly the invention and development of the steam engine necessitated the invention of Babbitt metal, and Mr. Babbitt merely hit upon the psychological moment in which to produce his invention, and very likely other minds were working on the same subject at the same time and were merely anticipated a little by Mr. Babbitt.

Mr. Babbitt was born at Taunton, Mass., June 26, 1799, and died in 1862. He was a goldsmith by trade and was said to have been the first manufacturer of Britania ware in the United States, which accounts for his having recommended the use of that metal as a lining for his boxes; in later years he manufactured Babbitt metal and soap.

As the question is often asked, and there is much doubt as to the original Babbitt formula, we give below an extract from the original patent:

"The inner parts of these boxes are to be lined with any of the harder kinds of composition known under the names of Britania metal or pewter, of which block tin is the basis.

"An excellent compound for the purpose I have prepared by taking about 50 parts of tin, 5 of antimony, and 1 of copper, but I do not intend to confine myself to this particular composition."

Prior to Mr. Babbitt's invention it was not thought safe to use for bearings any metal softer than brass or bronze. As soon as Mr. Babbitt demonstrated that it was practicable to use a white metal alloy, other inventors commenced experiments with various compositions in an endeavor to produce bearing metals that would possess better antifrictional qualities, and as these other metals came upon the market, Mr. Babbitt's formula was designated as "Genuine Babbitt," to distinguish it from other compositions, but thereafter all white metal alloys used for bearings became known as Babbitt metals.

With this end in view, Samuel Singley, a rolling mill superintendent, began some 40 yr. ago, a series of experiments and tests under varying and trying conditions, in an effort to produce something better than the metals then on the market, and after some 20 yr. of persistent effort, he succeeded in producing a metal so markedly superior to any he could purchase that its fame spread locally and he was induced by neighboring plants to supply this metal to them.

This was the alloy placed on the market in 1866, and which is now known the world over as Magnolia Antifriction Metal.

Despite the immense amount of research work done along these lines by scientists and others during the past 25 yr. or more, no one, it seems, has been able to improve upon or equal Genuine Babbitt or Magnolia Metal, and each in its class stands today supreme.

Magnolia metal is not only cheaper than Genuine Babbitt, but is found to possess other advantages which brought it into popular favor and very largely supplanted the use of Genuine.

It is now a well known fact that any white metal alloy used for bearings will fuse at from 450 to 500 deg. F., and that when the bearing becomes heated by friction or from other causes, to about 300 deg. F., it begins to soften and the weight of the shaft will cause it to squash out. It is very rarely the case that any bearing metal will squash out unless it does become heated from friction, and therefore a metal that possesses antifrictional qualities that prevent its reaching a destructive heat will outlast other metals.

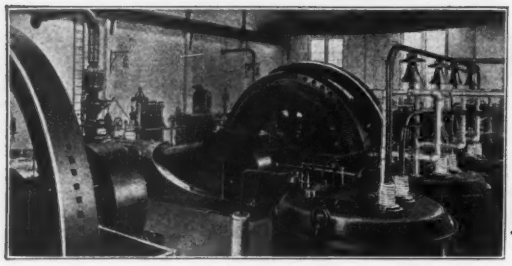
Therein lies the secret of Magnolia metal's success. And the reason is easy to explain and comprehend. Every journal, however true it may be turned, if examined microscopically, will show on its entire surface innumerable interstices and sharp cutting edges which act upon the bearing and add to the frictional resistance until worn down and filled in, and it has been found that Magnolia metal fills in these interstices and will condition the journal and bearing more quickly and more thoroughly than any other known metal, and imparts a smooth and highly polished surface to both the axle and bearing.

Furthermore, graphite is incorporated into Magnolia metal, which in itself is a lubricant of the highest quality. It has also been found that Magnolia metal is superior to other similar compounds where there is much grit and dust, or scant lubrication, and it also stands the heaviest pressures that are safe to put upon any bearing, and the highest speeds.

It is not at all uncommon for Magnolia lined bearings to run 5, 10 and even 20 yr., and because of the low coefficient of friction it shows a large saving in fuel, oil, wear, cost of rebabbitting, etc.

THE QUIETNESS WITH WHICH rope performs its work is very marked. From the small drive to one of large capacity, the same almost absolute silence is noticeable, and is a feature greatly appreciated by those enjoying its advantages.

ELECTRICAL MACHINERY AND APPARATUS



SAFETY DEVICES FOR ELEVATOR

By R. L. Mossman

OF FIRST importance in the study of safety devices used on electric elevators is the wiring diagram, as it is necessary to understand the wiring before it can be shown how the various safety devices perform their parts.

The wiring shown in Fig. 1 is for a 2-phase alternating machine, with direct current magnet control, the direct current being supplied from a small motor generator set as shown. The outline of switchboard is

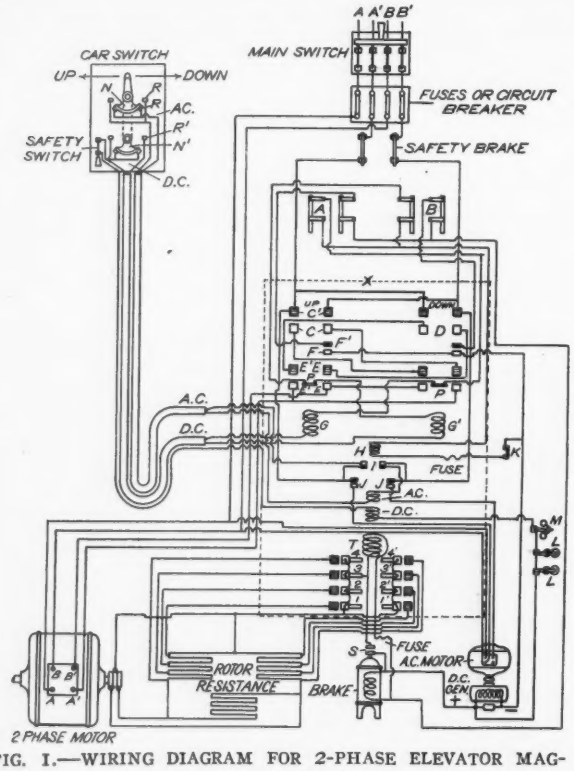


FIG. 1.—WIRING DIAGRAM FOR 2-PHASE ELEVATOR MAGNETIC CONTROL

shown at X. C and D are the reversing switches. In normal position the contacts E^1 E^1, E E and also P are together. When current flows in magnet G it operates the "up" switch C thereby making contact between C and C^1 also at F and F^1, and breaking contacts E^1 E^1, E E and P allowing current to flow through top contacts of C to bottom contracts of D and on to the a. c. motor. When switch D is operated by magnet G^1 one phase is reversed changing the direction of rotation of motor.

As will be seen by tracing out the wiring the magnets are operated by the car switch as follows: When the lever of car switch is moved to the left or "up" position the quadrant N makes contact between R and R which allows alternating current to flow through magnet A. C. which closes contacts J J thereby starting the motor generator set. The quadrants N N^1 are mounted on the same shaft but are shown separate for sake of simplicity.

By moving the lever to the other side contact is made at R^1 and N^1 which allows direct current from generator set to flow through G, H and D C. Magnet H opens contacts I, but contacts J J are held closed by magnet D C.

When contacts F F^1 are closed by the operation of switch C, direct current flows through brake magnet

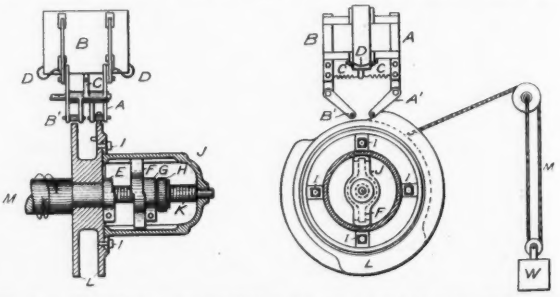


FIG. 2.—SECTION AND ELEVATION OF AUTOMATIC SWITCH

releasing the brake, at the same time the contacts S are closed allowing current to flow through magnet T which operates the resistance cut out 1, 2, 3, 4, as will be seen when cut out 4 and 4^1 is closed all resistance is cut out of rotor.

Safety Devices

The safety devices that operate first are the automatic switches A and B which are shown in detail in Fig. 2. B opens when the car is at the bottom floor and A at top floor. The cams L are mounted loose on the end of the main drum shaft M, an extension of the shaft is threaded as shown at K, on which are nuts E, F, G, and jam nut H. The nuts E and G are clamped to shaft K and revolve with it, nut F is loose and travels between E and G, according to direction of rotation. With the shaft revolving in the direction shown by arrow the nut F has traveled to G and is engaged by G causing F to revolve which revolves yoke J and cam

L opening switch A, which breaks the circuit in all direct current magnets and stops the motor. This will prevent the car from going up but it can be run down as switch B is still closed. The operation of A and B can be seen by referring to the wiring diagram. The limit of car travel can be changed by nuts F and G or by slacking set screws I, I, I, I, and turning yoke J on L. The weight W serves to hold cam L in central position. The switches are closed by springs C C.

Figure 3 shows the front and side elevation of safety brake. This is operated by cable P′ on sheave N, this sheave is free to revolve on shaft R, on this shaft is arm M free to revolve, in upper end of M is a pin K′ on which is the piece K which in normal position shown, holds up the weight arm J. Pin L is fastened into sheave N and engages the lower end of K as shown, as will be seen if the sheave N is revolved in either direction the action of pin L will cause M to move one

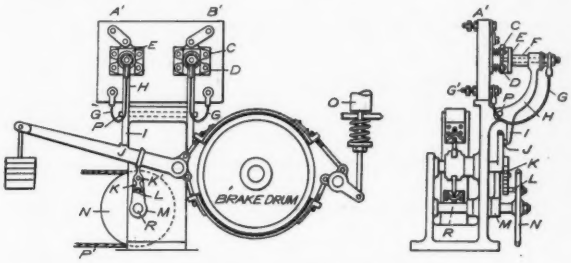


FIG. 3.—SIDE AND END VIEWS OF SAFETY BRAKE

side or the other and allow the weight to drop which sets the brake and at the same time disengages J from arm I which allows the switch H to drop open thereby opening circuit to motor.

The line is connected at A′ B′ and motor connection at G′ G. The switch contacts are shown at C E D, D being a copper contact block, while C is carbon, the circuit being opened by D first, while whatever arc is formed will be through the carbon block. F is an insulating bushing.

At the right of the brake drum in Fig. 3 is the lower end of the regular brake, O representing the plunger which is operated by a magnet not shown. The brake is applied by the action of the spring and released by the magnet drawing up the plunger O.

(To be continued.)

ELECTRICALLY DRIVEN PUMPS AT LOCKPORT, N. Y.

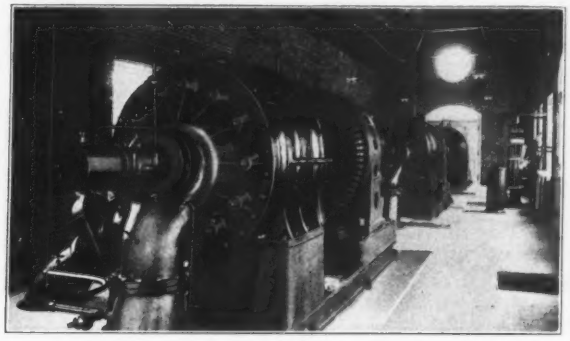
THE City of Lockport, N. Y., derives its water supply from the Niagara River near North Tonawanda, 13 miles away. From the electrically driven pumping station at this point, the water is forced through 69,000 ft. of 30 in. main to a standpipe 25 ft. in diameter and 120 ft. high at Lockport.

The pumping plant contains 3 independent units with a combined capacity of delivering 15,000,000 gals. in 24 hr. against a pressure of 125 lb. Each unit comprises a Westinghouse induction motor, designed for 500 hp. at 750 r.p.m., with 3 phase current at 400 volts, direct connected to a single suction, enclosed impeller centrifugal pump, made by the Holly Mfg. Co., Buffalo.

Power generated at Niagara Falls is transmitted to North Tonawanda at 22,000 volts and is stepped down to 440 volts at the pumping station by 3 500 kw., oil insulated, water cooled transformers.

The 3-motor driven pumping units were recently given a complete test, which developed some interesting economies of electric operation. Each unit was run continuously for 15 hr., during which time readings of the electrical input were taken every 5 min.; readings of the Venturi water meter every 10 min., pressure gage every 5 min. and revolutions of pump every 15 min. The results are given in the accompanying table, which shows that all 3 of the pumps exceeded the duty requirement of 27,000,000 foot-pounds by approximately 4,000,000 foot-pounds. It will be noted further that the temperature rises are well within the specifications, and that the pump capacities and horsepowers are well exceeded.

In the case of the Lockport pumping station, electrical energy is purchased at $16 per horsepower year The cost of power for this station is thus just about equal to that of steam operation under conditions assuming cross-compound pumping engines giving a



ELECTRICALLY DRIVEN PUMPS AT LOCKPORT, N. Y.

duty of 130,000,000 foot-pounds per 1000 lb. of steam; coal at $3 per ton delivered into the boiler room; 8.5 lb. evaporation under working conditions, and including labor for making steam and handling ashes, as well as increased fixed charges against the additional plant for operating with steam. This electrically driven pumping plant is thus developing duty equal to 130,000,000 foot-pounds per 1,000 lb. of steam.

TABLE.—RESULTS OF TESTS OF LOCKPORT'S MOTOR-DRIVEN PUMPING UNITS

	PUMP NO. 1	PUMP NO. 2	PUMP NO. 3
MAXIMUM REV. PER MIN.	746	752	744
MINIMUM " " "	738	738	739
AVERAGE " " "	743	744	744
MAXIMUM GAGE PRESSURE, LB.	148.5	144.5	143.5
MINIMUM " " "	119.5	139.5	134.5
AVERAGE " " "	136.9	148.6	138.9
AVERAGE HEAD, FT.	315.8	329.1	320.6
GAL. PUMPED PER HR.	238,000	236,300	236,700
GAL. PUMPED IN 24 HR. AT THIS RATE	5,712,000	5,672,000	5,712,000
KILOWATT INPUT PER HR.	342.4	346.1	341.5
GAL. PER KW. HR.	1,454	1,464	1,443
HYDRAULIC HP.	318	327	319.5
ELECTRIC HP.	456.6	458	455
EFFICIENCY PER CENT	69.6	71	70
DUTY, FOOT-POUND PER 1000	30,800,000	31,000 000	31,000,000
DEG. TEMP. RISE IN 15 HR.	41	38	43

In connection with this plant which is pumping its output about 13 miles to Lockport, it may be of interest to note that last summer when a large fire broke out there, 11 powerful fire streams through varying lengths of hose were maintained from the standpipe and pumps as long as needed for service.

The entire water supply of which this station forms a part, as well as the station itself, were designed by Charles A. Hague, consulting engineer, New York City.

To find the diameter of the diven pulley, multiply the diameter of the driver by its speed in revolutions per minute and divide by the desired speed of the follower.

SOME ELECTRICAL PROBLEMS

SWITCHBOARD AND TRANSFORMER CONNECTIONS

IT IS desired to add a 3-phase, 100 kw. generator to a plant which consists of 2 single-phase generators, one of 180 kw. and the other of 30 kw. capacity.

The arrangement of the switchboard for the 2 single-phase machines is as shown in Fig. 1. It is also desired that the entire load of the plant, when running light, may be carried on any one of the 3 machines. What would be the best and least expensive arrangement of switchboard wiring with the equipment that is available?

In making the connections in this system care must be taken to arrange switches so that they can easily be seen, or otherwise cross-connections between the machines is liable to make trouble. It is possible with the new 3-phase machine to run 3 single-phase circuits

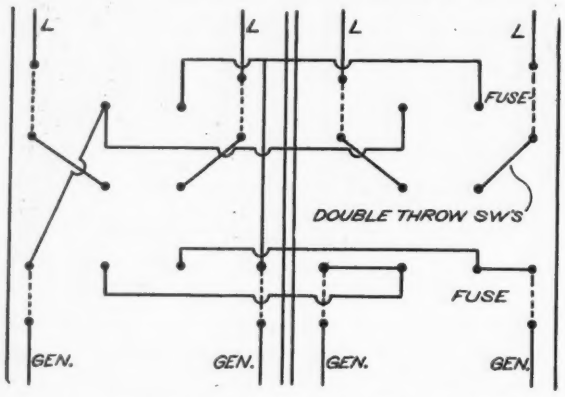


FIG. 1. SWITCHBOARD DIAGRAM FOR 2 SINGLE-PHASE GENERATORS

at the same time and in this way get the full capacity of the machine. The arrangement shown in Fig. 2 will accomplish this result.

From the 180 kw. generator connect to 1 pair of bus bars, which can also be connected to the B phase of the 3-phase machine. From the 30 kw. generator, connect to the upper set of bus bars, and these bars may be connected to the A phase of the 3-phase machine. If only the 2 phases are used without connecting the other one, the capacity of the 3-phase machine would be ⅔ of its rated capacity or 67 kw.

By splitting up the circuits into 3 lines, the No. 3 line can be thrown on either the 180 or the 30-kw. machine by a double-throw switch, the same as the others, and also by a separate connection, as shown, arranged to throw it onto the C phase of the 3-phase machine. In this connection one line must be taken from each of the phases, that is, the A phase would be starting from the terminals of the machine, as shown in Fig. 3, between one outside wire and the middle wire, the B phase between the other outside wire and the middle wire, and the C phase between the 2 outside wires. It will thus be necessary to run 2 wires from each terminal of the generator, or else run a 3-pole connection on the switchboard, and then take 2 wires from each terminal there. The latter would probably be the better way.

What are the connections employed for connecting up 3 single-phase transformers, such as are used in railway sub-stations, with Y connections on the high tension side and delta connection on the low tension or secondary side? Also what connections would be made in case one wished to cut out 1 transformer, and run on the other 2?

To connect 3 single-phase transformers in Y on the high tension side, 1 terminal from each transformer is connected to the same bus bar or wire, the other 3 terminals are connected to separate wires of

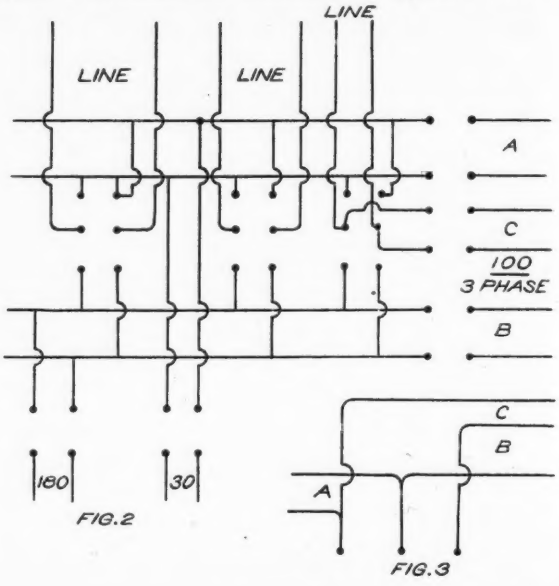


FIG. 2. DIAGRAM FOR 2 SINGLE-PHASE AND 1 3-PHASE GENERATORS

FIG. 3. GENERATOR LEADS CONNECTED IN Y

the transmission line. The low-tension terminals from each transformer are connected together as shown in Fig. 4, with taps taken off from these connections at A, B, and C, which run to the terminals of the rotary converter.

If it is desired to run the converter on 3 phase, employing only 2 transformers, it will be necessary to use the T connection as shown in Fig. 5, or the open delta connection as is shown in Fig. 6. Either one

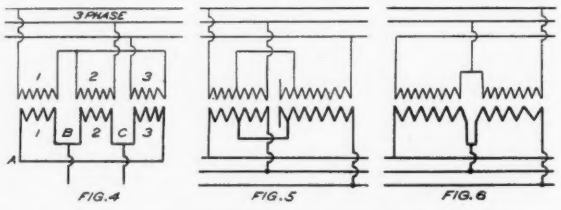


FIG. 4. TRANSFORMERS CONNECTED Y TO DELTA

FIG. 5. T CONNECTION FOR TRANSFORMERS

FIG. 6. TRANSFORMERS CONNECTED IN OPEN DELTA

of these methods will necessitate the changing of the high tension connections as the open Y gives an unbalanced voltage.

What changes would be made on the rings of the rotary as each change is made on the transformers? The rotors are run on 3-phase, 3-wire systems.

As any changes of the connections to the transformers outlined in the above paragraph will not

change the phase relation between the currents of the secondary circuit, it will not be necessary to make any changes whatever in the wiring of the rings on the rotary converter. The voltage of the secondary circuit will, however, be 1.73 times that of the original connection.

With 3 transformers connected to a single-phase 3-wire lighting circuit, as shown in Fig. 7, what is the voltage and phase relation existing in the transformers which are used for lighting and driving motors.

This is simply an Edison 3-wire system in which the outside wires on the low tension side would give current at 220 volts for driving 220 volt motors, and from the middle wire to either outside would give 110 volts for lighting. Transformer 1 is therefore run on at 220 volts, Nos. 2 and 3 at 110 volts each, these serving chiefly to furnish the current needed on the lighting circuit, while the 220 volts furnish the current on the motor circuit. In other words, transformers 2 and 3 answer the same purpose as a balancer on a 3-wire direct current Edison system. The con-

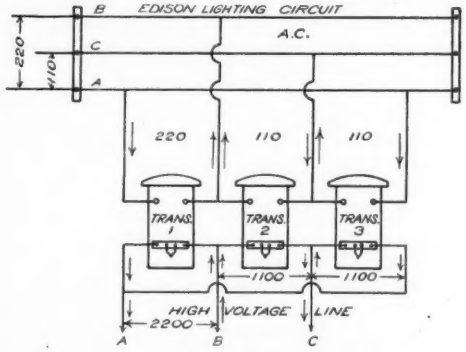


FIG. 7. EDISON 3-WIRE SYSTEM

nections on the high tension side are practically the same. The voltage between wires A and B, assuming a ratio of 10 to 1, would be 2200, between B and C would be 1100, and between A and C 1100. Since the transformers are all connected to the same circuit the phase of the current is the same.

In the following 4 cases give the primary voltage, and current through transformers, and also secondary line current, and voltage, each transformer is single-phase, of 10 kw. capacity with a primary rating of 1000 volts, and a secondary rating of 100 volts.

Case 1 consists of 3 single-phase transformers connected with the primary to a 3-wire, 3-phase line of 1000 volts, with both primary and secondary windings connected in delta.

Since the primary voltage of this circuit is 1000, and the ratio of transformation in each transformer is 10 to 1, the secondary or low tension voltage will be 1000 divided by 10, or 100 volts. As the capacity of each transformer is 10 kw., or 10,000 watts, and the primary voltage is 1000, the current carried by the primary coils will be 10,000 divided by 1000 or 10 amperes. In like manner the current in the secondary coil will be 10,000 divided by 100, or 100 amperes. To obtain the line current multiply these values by 1.73; this gives 17.3 for the high tension and 173 for the low tension line currents.

Case 2 is the same as case 1, with the exception that the transformers are connected both primary and secondary in Y.

With a voltage of 1000 across each phase of the line, the voltage between the terminals of the high tension side of each transformer will be 1 divided by 1.73, or 0.58 times 1000, equals 580 volts. As the transformer was designed to carry 10 amperes on the high tension coil, this current should not be increased, except for short periods of time. As the ratio of transformation in the transformers is 10 to 1, the voltage between the secondary terminals of each transformer will be 58, and that between the lines A and B, B and C, C and A, will be 1.73 times 58, or 100 volts. The current in the secondary coils will be 10 times that of the primary coils, or in this case 100-amperes. The current in each line wire is the same as that in the transformers.

Case 3 is as shown in the diagram Fig. 10, with the high tension sides of the transformers in delta and the low tension in Y.

The voltage and current relation in the high tension side of the transformers is the same as in case 1,

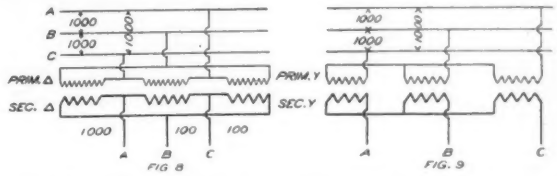


FIG. 8. DELTA TO DELTA TRANSFORMER CONNECTION.
FIG. 9. TRANSFORMERS CONNECTED Y TO Y

namely, 1000 volts between terminals, and 10 amperes of current. On the low tension side, if the voltage transformation is 10 to 1, the voltage across the terminals of each transformer is 100, but that between the line wires A and B, B and C, C and A is 1.73 times 100,

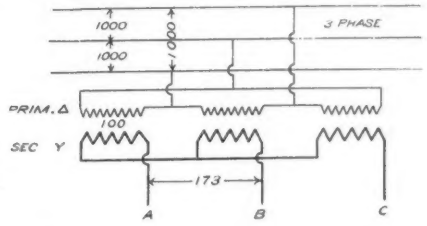


FIG. 10. DELTA TO Y CONNECTION

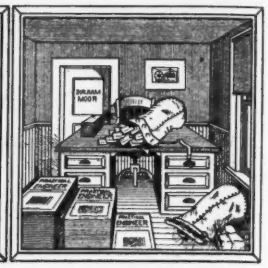
or 173 volts. The current carried in each low tension coil, will be 10 times that of the high tension coil, or 100 amperes. The high tension line current will be $1.73 \times 10 = 17.3$ amperes, while that in the low tension line is 100 amperes.

Case 4 is that of case 3 reversed, with the primary in Y and the secondary in delta.

This connection is the same as shown in Fig. 4. Here we have a voltage of 1000 between the line wires on the high tension side which makes the voltage between terminals of the transformers $1 \div 1.73 \times 1000 = 580$ volts. The current, of course, should not exceed 10 amperes, for which the transformers were designed, this is also the current in the high tension line. On the low tension side, with the transformers connected in delta, the voltage of the line between A and B is the same as that between the terminals of each transformer, and is equal to 0.1 the voltage across the high tension terminals of each transformer, that is, $580 \div 10 = 58$ volts. The current in the low tension coils will be 10 times that of the high tension, or 100 amperes, but that upon the line wires A, B and C will be $1.73 \times 100 = 173$ amperes.

Letters From Engineers

Tell us about your new kinks and new thinks. Rough sketches are always helpful; we make the drawings. Cash paid for accepted contributions.



Overworked Boilers Cause Wrecked Engine

The chief engineer of the power house where I work, a good practical man, always looked out for the weak points of the plant.

We had 5 return tubular boilers 6 by 18 ft., one was cut out Sunday night for cleaning and cut in again the following Saturday morning, but our load kept increasing and it was hard work to keep up steam at peak loads with 4 boilers.

The chief notified the manager and superintendent who were brothers, that another boiler was needed. They were very much surprised, and could not see it,

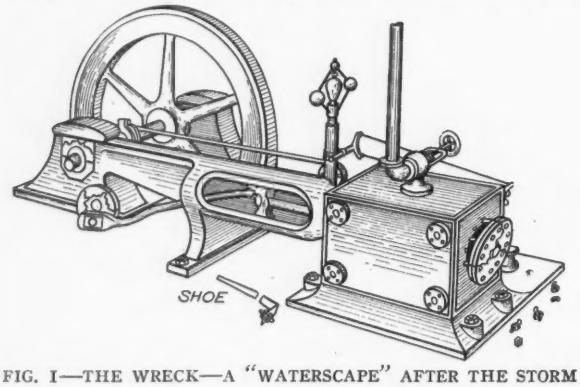


FIG. 1—THE WRECK—A "WATERSCAPE" AFTER THE STORM

as the station was running only 2 yr. and they had experts figure on it who knew their business. The chief told them that the load had increased 50 per cent, which they could see by the daily reports, but they did not want to see.

It worried the chief a good deal and he would tell them of it every once in a while, and point out the

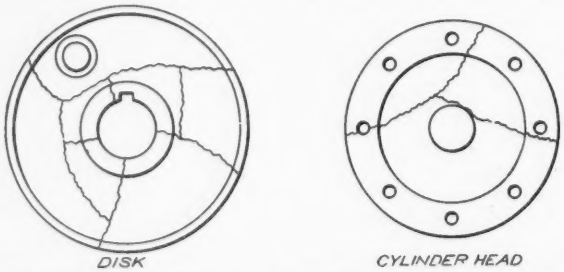


FIG. 2.—A WELL BROKEN DISK AND CYLINDER HEAD

danger, as they knew nothing about steam engineering. It got so they took it as a joke, when the chief would talk another boiler.

We ran along this way for a year; the steam was kept up, with the aid of an extra fireman on watch but the boilers had to be cleaned as the feed water was none too good. One day last winter a boiler was cut out for cleaning and repairs to brick work. When the 6 o'clock load came on, I was on watch and heard one of the engines banging. I tripped the line circuit breakers and pulled the switches and the noise stopped.

As chiefie had not yet gone home, he was in to know "what was the trouble?" I told him the little engine was taking over water. She was an 18 by 36-in. noncondensing, running 120 r. p. m. direct connected. The chief went to the boiler room and found everything O. K. I put the breakers and switches in again and chiefie and I stood watching the ammeters for about a minute, when a big load came on again, 2 or 3 loud reports were heard and a hissing of steam. I tripped the breakers again and pulled the switches of the little engine and closed the throttle valve.

When the steam cleared away we found the engine as per sketch, head cracked in 2 places and studs, springs and pieces of rings, scattered about the floor, piston sticking out of the end of the cylinder with a piece broken off and stuck in the crank end exhaust valve, which was broken in 2, crosshead turned one-quarter way around and both shoes broken. The disk was in a heap in the crank pit, in about half a dozen pieces. One piece was hurled against the side of the building. The pieces broke off as shown in Fig. 2, none of the disk remaining on the shaft.

Chiefie called up the manager on the 'phone, who came and had a look, but said nothing. Needless to say we had another boiler installed right away and bids asked for the repairing of the engine. Luckily nobody was hurt, but the wreck could have been prevented by paying more attention to the chief engineer.

Thomas Sheehan.

False Water Level in Boiler Gage Glass

Steam leaking through the packing at the top gland of the water gage glass, the gland of the steam valve, the top nut of the gage fitting, or at the screw between the fitting and the water column may cause the water in the glass to rise considerably above its true level. A comparatively slight leak at any of these places, particularly with high pressure steam, may easily reduce the steam pressure in the glass to 1 lb. or more below the pressure in the boiler, as the passage admitting steam from the water column to the glass is usually quite small.

Suppose this to happen. In such a case 0.1 lb. pressure represents a column of water 2.75 in. in height, taking 0.037 lb. as the weight of a column of water, 1 in. in height and 1 sq. in. cross section. The water in the glass will, therefore, settle 2.75 in. above its true level, the weight of the 2.75 in. of water, 0.1 lb. being required to compensate for the reduction of the steam pressure due to the leak.

A similar leak at the other end of the glass would cause the water to settle below its true level. In such a case if the leak cannot be stopped at once, the test cocks should be used, as, whether on the boiler itself or the water column, they would not be affected like the glass.

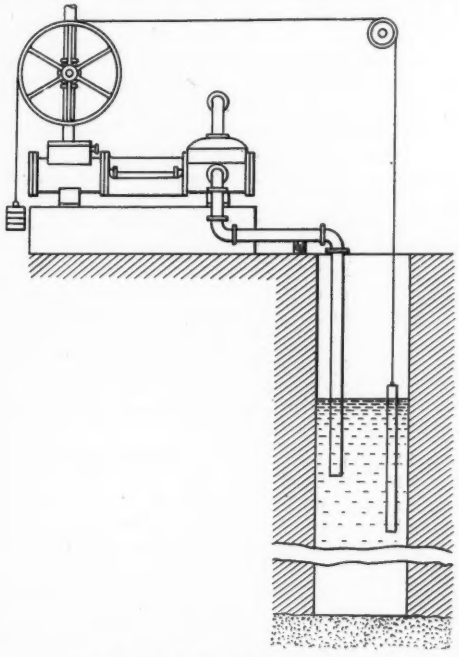
Manitoban.

Finding a Use for the Pole

I am sending you an account of a pump trouble and the way in which I overcame it which may be suitable for Practical Engineer.

We have a 500-ft. well in which the water is normally 30 ft. from the surface and from which we pump water for use about the plant, the intake pipe extending down 50 ft., or 20 ft. below the normal level. At times the demand for water is so heavy that that 20 ft. is all pumped out and when this occurs the pump racks away unless somebody is near to shut off the steam.

To do away with this racing, I rigged up the outfit as shown. I put a V grooved wheel in place of the regular handwheel on the pump throttle valve and over this passed a stout rope to one end of which is tied a weight and to the other a pole that is let down



POLE AS A PUMP REGULATOR

into the well. Now it is easy to see that this forms a perfect regulator—as the water gets down below the suction level, the pole follows, and with it the rope passing over the valve wheel, completely shutting off steam from the pump. As the water rises, the pump is automatically started unless the man in charge has, for any purpose, locked the valve.

The pole is weighted slightly to keep it in position and a little experimenting determined the amount of weight necessary at the other end of the rope.

Silas F. Cronk.

Truing a Shaft

There are a number of ways in which to varify the alignment of a cross compound air compressor without removing the pistons. I prefer the method of placing a straight edge against one of the cylinder heads on the crank end and tramming the distance between the edge and the shaft at the cylinder, and at the end of the straight edge; if both are equal the shaft is in line, providing the shaft has the same diameter at both tramming points. If there is any difference, make the proper allowance.

In some types of engines the crank and cylinder heads of the high and low pressure cylinders are on a straight line with each other. Should this be the case, tram the distance between the shaft and the cylinders and in that way square the shaft without the use of a straight edge.

G. H. B.

Making It Hot for the Office. Thawing a Stone

Figure 1 shows a part of our shop building, also one of the shop offices. It always had been too cold in this office to do any work during the winter, so it was decided to place some steam coils in the room. The shop was heated by exhaust steam from the engine.

As this office was located about 90 ft. from the engine room, I did not like the idea of running another feeder line from the exhaust pipe of the engine to the coils in the office. There were steam coils in the shop along one of the walls where the office is located and as very little steam is needed to heat the room, I decided to cut the top steam coil, which is 1.25 in., in the

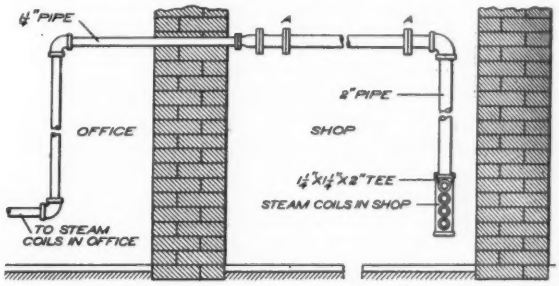


FIG. 1—PLAN OF SHOP AND OFFICE SHOWING LOCATION OF COILS

shop and place a 1.25 by 1.25 by 2-in. tee in here, then run a 2-in. pipe from this tee to the wall of the office, reducing this to 1.25 in. where it leads to the steam coils in the office as shown in Fig. 1.

The horizontal 2-in. pipe will be taken down during the warm months by disconnecting the 2 flanges A and

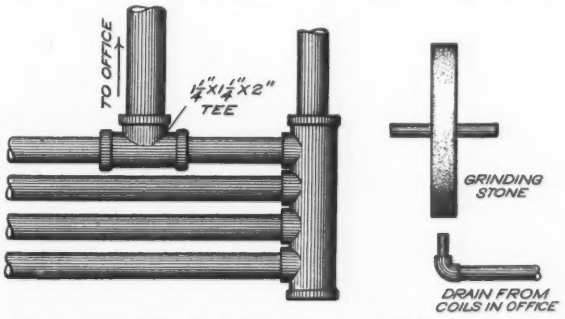


FIG. 2—SIDE VIEW OF STEAM COILS IN SHOP AND CONNECTION

FIG. 3—ARRANGEMENT OF PIPE UNDER GRINDING STONE

A. After this job was done, there was plenty of heat in the office. Figure 2 shows a side view of the arrangement.

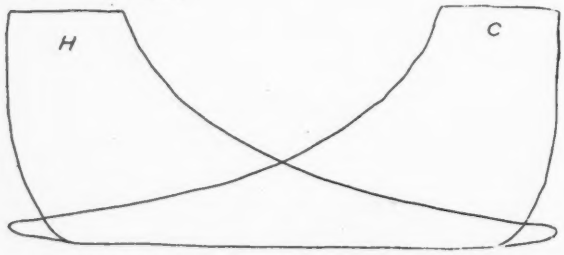
In placing the steam coils in the office we overcame another trouble. One of our large grinding stones is located near the office, and as the shop is not heated during the night, the stone would freeze each night so that it had to be thawed out in the morning by using hot water or building a fire under it. This usually took 2 or more hours while the men had to wait before they could grind their tools, thereby wasting time. To overcome this, the drain pipe from the

office coils was run under the stone with an ell facing up as shown in Fig. 3; then by opening the drain valve, in the office wide, the grinding stone would be thawed in a short time by the steam coming through the drain pipe. Then the ell was turned down, the valve in the office nearly closed and water of condensation would soak into the ground under the stone.

H. Jahnke.

Diagram From a 10-Year Old

Herewith is the indicated card taken from a Corliss engine 14 by 30 in.; 90 r. p. m.; boiler pressure 90 lb.; and spring 50.



INDICATOR DIAGRAM FROM A 10-YR. OLD CORLISS

I want to ask the boys what they think of it. The engine has been running 10 yr. and seems very economical.

G. G. Blank.

Boiler Compound Feeder

A most convenient way of getting boiler compound into a boiler is as shown in Fig. 1; with this arrangement it is not necessary to use many fittings, nor to make much change in the feed pipe, as most feed pipes on a boiler have a stop valve next to the boiler and a flange or union next to this valve. All that is necessary is to disconnect this flange or union and place a cross in the pipe with a valve in the top and bottom outlets, then place another stop valve next to this cross in the feed pipe. The distance between the check valve and this valve should be made long enough so that the pipe between the check and stop valves will take the desired amount of compound, which is to be put into the boiler.

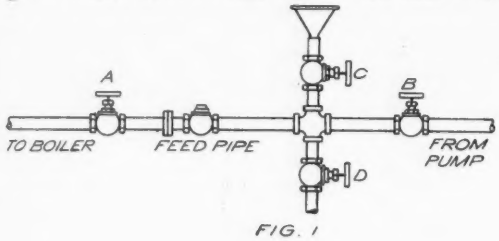


FIG. 1

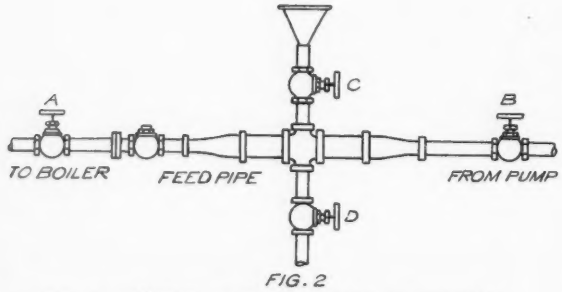


FIG. 2

FIG. 1.—COMPOUND FEEDER MADE OF FITTINGS
FIG. 2.—ARRANGEMENT FOR FEEDING A LARGE AMOUNT OF COMPOUND

To operate the feeder stop the feed pump or injector, then close the valves A and B and open wide valves C and D. When all the water has run out of the pipe between valve B and check valve close valve D and place the desired amount of compound into the pipe through the valve C. Then, after closing C, open valves A and B wide and start feed pump or injector.

If the distance between the check and valve B can not be made long enough to hold the desired amount of compound, a larger piece of pipe could be placed between the check and valve B with a reducing coupling on each end as shown in Fig 2.

H. A. Jahnke.

An Overworked Engine

An engine is like a horse, only the horse has senses and when overloaded refuses to pull; he may get abused if his driver is not competent, and the same is true of the engine. It can do so much without showing any sign of weakness, but when the load becomes too heavy, its speed slackens, and if something is not done it will run slow speed, and that is why so many men in the business have so much trouble. While they may not be directly responsible for some of it, still it is bound to come if the engine is kept with a big overload for a long time.

I have in mind an engine that has done duty for 18 yr. and was a much abused engine. Simply because the man who designed the plant, and not knowing the machinery to be operated, got the engine too small, and a plant that is growing cannot stand idle and make dividends for the stockholders. The dimensions of the new engine was 26 by 48 in. and ran at 96 r. p. m., with a boiler gage pressure of 100 lb. The best it could do was 570 i. hp. and the amount of power required was 650 or 700 i. hp.

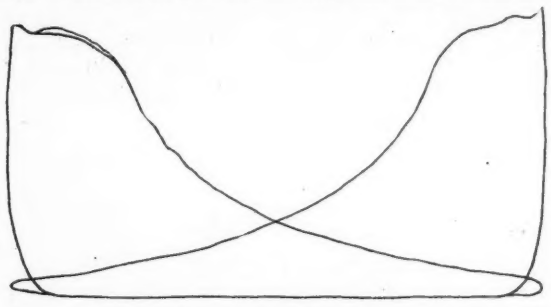
The company was buying power from a private concern who ran by water, but there was no surety from day to day, and at times when power was needed most it could not be had because of the scarcity of the water. It happened to be the dry season of the year when the engine was started and when all the machinery was on, it would not keep up to the required speed, and some of the machinery had to be left standing idle until the erecting engineer was satisfied with the adjustments. So after a week's run the cover was taken off the cylinder to see how it looked and it showed to be wearing badly.

The steam rings were adjusted and were not set out so hard and when the engine was started again more oil was given to the cylinder in hopes to stop the wear, but when the cover was taken off again it made no difference, it wore just the same and as bad as before. After doing everything that could be done for it, it continued to wear as though it was sandstone, and after a year it had to be bored out and a new set of steam rings fitted. The man who came from the engine works said the cylinder was a very soft casting and was too small for the amount of work it was doing and recommended a new cylinder of larger diameter, and so long as the old cylinder was no good, the company was bound to have power and never taking into consideration the other parts of the engine, ordered a new cylinder 4 in. in diameter larger than the old one and to fit the old engine bed.

The dimensions of the new cylinder are 30 by 48 in. to run at 96 r. p. m. at a boiler gage of 160 lb. The company got in new boilers designed for such pressure and sold the old ones. True, the company got more power from the change, but the other parts of the engine were never designed for such stresses and the

consequence is that there is something giving trouble all the time. The company was prosperous and kept increasing their output and would add a few machines now and then. Next the belts gave trouble, as they have a limit as to how much they can pull, and one day a large driver broke and did considerable damage.

If the management had listened to the engineer they would have been spared a shutdown, for he wanted to have a rider belt put on to help the then overloaded



CARD FROM AN ABUSED ENGINE

one. The belt was ruined and a new one was purchased at an expense of nearly $400, I was told, and now all the heavy drivers that were overloaded have riders to help them. I am not a believer in rider belts, but under the circumstances it was the cheapest way.

The officials thought so long as the belts were all right they could add some more and still have no trouble, but one day the engine bed broke, as might be expected, and caused another shutdown. The bed was patched to do for a while until they got a new bed plate. The new one was to be a great deal stronger than the old one, but when it was weighed it was 150 lb. lighter than the old one. It was put in position and fitted up and did pretty well, but was too springy. It broke 2 foundation bolts and new ones were put in and set up as hard as they would stand. The next place to give trouble was the flange on the foundation that surrounded the main bearing pedestal, making the crack run into the crank pit.

Now the officials are willing to take off some of the load, but it is too late. The engine is no longer safe, unless another new bed plate is bought and put in position, for when the support is taken away from the main bearing as it is, it is liable to break in some other place and cause a lot of trouble. Perhaps the readers might say it was not lined up properly, but I can say it was in line, and for the benefit of the readers I am sending this indicator card that was taken from it just before the last break to show the distribution of steam. I would like to have the readers say what they think of it. M. J. C.

A Chief Engineer's Problems

I submit to your readers a few questions for which I would like as complete and practical answers in as early an issue of Practical Engineer as possible.

1. Would like some one to explain in detail, methods of cutting iron beams, etc., with an electric arc.

2. Would like description of automatic sprinkler fire protection system for a 4 or 5-story building. Give it as complete as possible with the text and sketches, giving size of piping, necessary apparatus, etc.

3. Can a fuel change be made with a Dutch-oven furnace, say wood to coal, and coal burned more economically than in ordinary boiler setting furnaces?

4. Can the alignment of an engine be verified as to correctness without stripping the engine and running a line through cylinder? If it can, will some one explain with sketches how this can be done with a Corliss or slow speed engine or high speed center crank?

5. In figuring current consumption of multiple arc lamps for a flat rate basis, is it proper to take line voltage or voltage at arc? In other words, who shall pay for loss in lamp resistance?

6. Would like a description and sketches of home-made wood cooling towers, giving dimensions best suited for proper cooling per horsepower, figured on hot weather basis. With ordinary type of jet condenser, would air pump be all right for elevating water to tower? Give dimensions of reservoir under tower and provision in its build to provide for oil separation.

7. Have any of the readers a condenser designed from piping exposed to the atmosphere with cooling water flowing over exterior? If so, what size of pipes are used, how many feet necessary, how is it built, giving sketch and how are air pump and exhaust pipes connected? Give proportions necessary per horsepower and amount of cooling water required.

C. Dickerson.

Repairing a Cracked Flange

Figure 1 shows a cracked flange on a steam pipe made of cast iron which leaked very badly. Not having the time to have a new one made, it was taken down and put in a lathe and the flange cut off. Threads

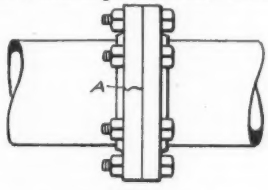


FIG. 1

FIG. 1.—CRACKED FLANGE

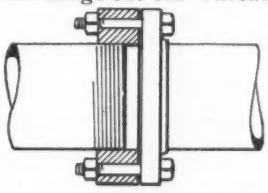


FIG. 2

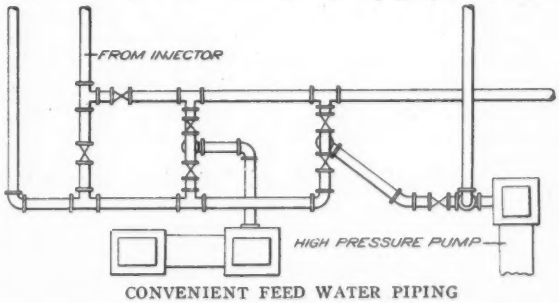
FIG. 2.—REPAIRED FLANGE

were cut on the end and a flange was made twice the thickness as the one cut off. This was threaded and screwed on the pipe, which was then put in place and marked for the bolt holes, after which it was taken down and holes were drilled.

The pipe was then put back in place and tightened up, using longer bolts. Figure 2 shows method employed. This joint has been in use over a year and shows no leak. An Engineer.

Feed Water Piping

The accompanying illustration shows the feed-water piping of the plant where I am employed. There are 2 boilers and they are so piped that they may be fed either by a boiler-feed pump, a high pressure pump



CONVENIENT FEED WATER PIPING

or an injector. Both may be fed at the same time, either one or both through the front head or blow off by either one of the pumps, or by a pump and the injector. Of all the arrangements I have ever seen, this is the best in this respect. H. Skaton.

Diagrams for Criticism

The accompanying diagrams were taken from an 18 by 24-in. Monarch engine having Corliss valves and equipped with a fly-wheel governor. The engine is direct connected to a direct current generator of 150 kw. capacity. Cards 2 and 3 were taken with about 3 lb. pressure, which is used to heat the plant. Card

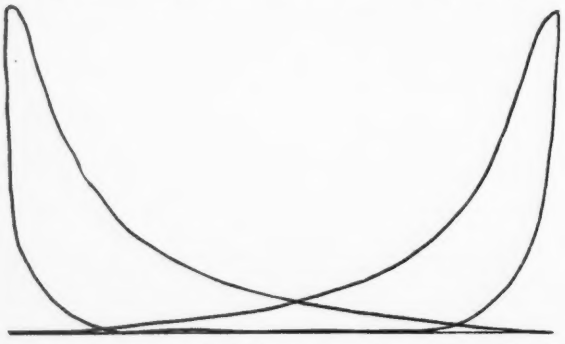


FIG. 1.—CARD FOR 0.25 LOAD AND 3-LB. BACK PRESSURE

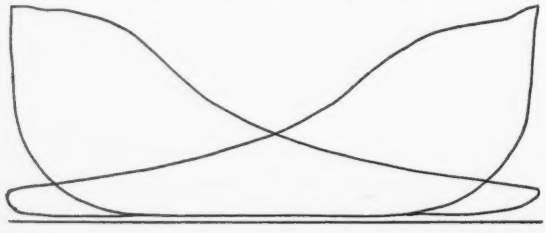


FIG. 2.—DIAGRAM TAKEN WHILE RUNNING ON ⅔ LOAD

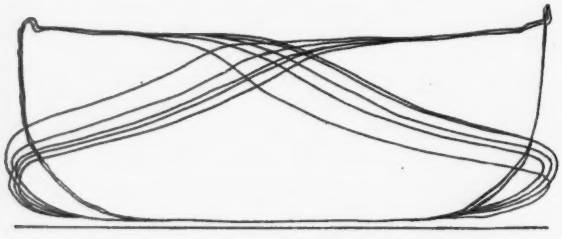


FIG. 3.—DIAGRAM OF FLUCTUATING LOAD

3 was taken while load was fluctuating between 0.75 and full load. I would like to see comments on or improvements which my engineer friends may suggest.

B. M. Babcock.

A Lubricator Experience

About 9 yr. ago we had a 20 by 36 by 42-in. cross-compound condensing engine installed. It was equipped with a double feed cylinder oil pump and 2 gravity sight feed lubricators. We used the pump as it was less bother to fill. We fed about a gallon of non-corrosive cylinder oil into both cylinders every 52 hr.

The pump delivered the oil into the low pressure side at A, Fig. 1, and the engine seemed to get all the oil that was necessary and everything went well until our pump got broken. While waiting for new parts we started our lubricators which were connected, as shown in Fig. 1, on low pressure. We tried to regulate the drops so as to feed about the same amount of oil. But no matter how we regulated the valves at B and C, the lubricator would rather feed a stream or not any. So we almost closed C and B and then we were feeding a quart every 4 hr.

The chief complained on the amount of oil used, but it was the best we could do. After running about half a day we were surprised to hear a groaning in both valves and cylinders. Then the steam valve dash pot plungers started to stick up and everything pointed to a scarcity of oil. It went so bad we had to shut down.

The trap from our receiver empties into an open drain in the engine house basement and that drain looked as if some one had emptied a barrel of cylinder oil into it.

It seems the oil entered the pipe and instead of going into the cylinder or steam chest it followed the pipe down to the receiver and then out the trap.

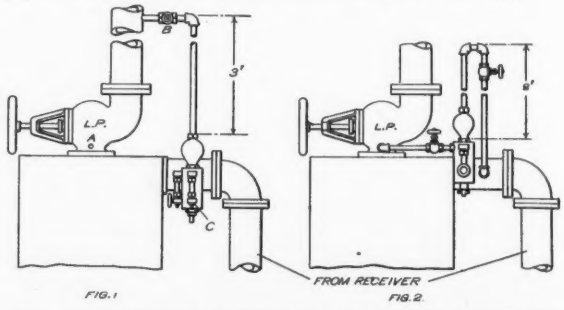


FIG. 1.—INCORRECT METHOD OF ATTACHING LUBRICATOR

FIG. 2.—PROPERLY CONNECTED LUBRICATOR

We changed the lubricator as shown in Fig. 2 and now we can feed as many or as few drops we please, and it all goes to lubricate the valves and piston. And we feed less than with the pumps.

A. W. Griswold.

A Connecticut Boiler Explosion

On the evening of December 1st, a Bigelow boiler of 100 hp. capacity exploded in the factory of Radcliffe Bros. in Shelton, Conn. This factory is engaged in the manufacture of woolen underwear and hosiery, and has in its employ about 300 hands. The explosion occurred at 6:30 p. m. when all the employees had left their work, with the exception of the fireman, whose body was found under the debris, and the night watchman, who had come on duty but a short time before and who was in the office. He escaped serious injury save for cuts and bruises.

As may be seen by the diagram, Fig. 1, the building in which the boiler was located stood in an angle of the "L" formed by 2 5-story brick buildings, in which is located most of the machinery. It was a 2-story structure, and contained, beside the boiler and gas generator, the dyeing department and storerooms for raw material.

Nothing was left but an immense pile of brick and timbers, pieces of the boiler, and bales of smoky and water-soaked wool.

The boiler room being so enclosed on all sides by the other buildings, the debris was, of course, carried high in the air over the surrounding walls; 2 blocks away planks, piping and plates of boiler metal were found, while a steel pulley weighing about 400 lb. broke in the roof of a house 100 yards away. The Huntington Piano factory and Whitlock Printing Press factory suffered much damage from the masses of brick and other wreckage that were thrown through the windows upon valuable lathes and other machinery. The damage to the 3 plants is estimated at between $200,000 and $250,000.

The wrecked boiler was of ⅜-in. metal with double

riveted seams. Owing to the expansion and contraction of a boiler, when heated and cooled, there is more or less motion and crystallization sometimes takes place. For instance, take a piece of soft wire, bend it back and forth until it becomes heated or crystallized when it will easily break. Practically the same process took place on the shell next to the seam and this constant expansion and contraction weakened it until finally the pressure probably being greater than usual,

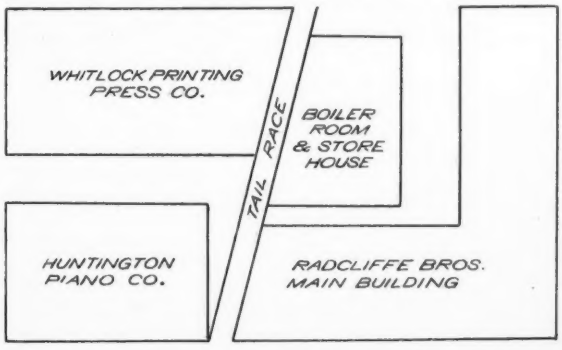


FIG. 1. PLAN SHOWING ARRANGEMENT OF BUILDINGS

the shell gave way. All that can be accounted for by practical men is the extreme tightness of the riveting.

The force of the explosion was more severe from the fact that the boiler was full of water. As experienced men know, a full boiler which blows up causes more damage than an overheated one into which more

FIG. 2. WRECK OF GAS PRODUCER AND RECEIVER TANK

water is pumped, as in the latter case the boiler will merely topple over.

It has been proven beyond doubt that on the night in question there was plenty of water in the boiler at 6 o'clock, at which time the plant ceased operation and it would be impossible for the water to be exhausted in the half hour which elapsed, there being no steam taken from the boiler and the fire banked.

Figure 2 shows a gas producer and receiver tank raised from their foundations and deposited in the tail-race used by the surrounding factories, having been carried a distance of 10 ft. In the background is a piece of the shell showing the manner in which it was torn from the boiler by the force of the explosion and thrown about 100 ft. from its foundation. The hole in the brick wall of the main building shows where the front of the boiler struck, breaking heavy shafting and also moving machines of enormous weight.

Figure 3 is a view of the same section of the shell taken at closer range.

The insurance for the damage to the plant can not be recovered as little loss was suffered by reason of fire, and only the amount carried on the boiler will

FIG. 3. PORTION OF BOILER SHELL

be paid by the insurance company. Inspectors who were on the scene of the disaster soon after it occurred declare the accident to have been unavoidable.

R. J. Whiting.

ROPES CAN BE USED to greater advantage when driving and driven shafts are not parallel than can any other system of band or link connection. Not only when shafts are slightly out of alignment, but when in any plane and at any angle with each other, and at any distance apart, can power be more easily carried. This makes a most satisfactory way of overcoming natural obstacles or for taking advantage of opportunities not allowable with parallel shafts, especially when the driving parts cannot be protected from the weather inclemencies.

TENSILE STRENGTH OF BOILER plate, not intended to be worked in the fire, or exposed to flame, should be 27 to 32 tons per square inch. That of other plates, 26 to 30 tons. Elongation not less than 20 per cent in 8 in. for material ⅜ in. thick and upwards for former, and 23 per cent for latter; less than ⅜ in. reduction, not more than 3 per cent below the above for each ⅛ in. diminution in thickness.

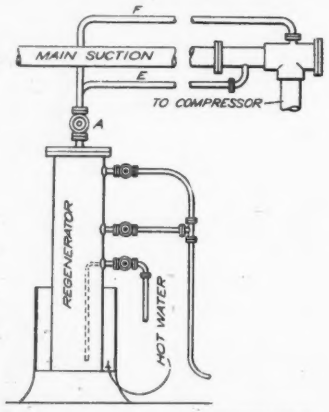
Questions and Answers

Ask about your troubles—help the other fellow with his. Give your name and address. For a quick answer enclose stamp for reply.

Regenerator Connection

Don't you think the proper way would be to have the regenerator connected as at E on sketch so the dead liquid could drop in before it reached the compressor? The regenerator was connected as shown by the pipe F when I took charge of the plant.—E. W.

A.—The connection of the regenerator would better be left as at F. The object of the regenerator is to remove from the ammonia all impurities. If the



CONNECTIONS TO REGENERATOR

connection is changed, as at E, there will be some liquid flowing from the main suction pipe down into the regenerator against the current of ammonia gas going from the regenerator towards the compressor. This would be likely to result in the gas picking up some oil and impurities from the drip. If there is much bother with liquid shooting into the compressor, put in a separator in the main suction line and take the liquid from this to a receiving tank, from which it can be pumped back into the expansion system under pressure.

Power Plant Troubles

1. If lap is added what part of the valve gear must be changed?

2. What is the horsepower of a boiler feed pump with 6-in. steam cylinder, 10-in. stroke 4-in. water cylinder, 100-lb. steam pressure, running at 60 strokes per minute? Explain how you get the number of foot pounds in this problem.

3. If you had a new piston and could not stop its leaking what would you do?

4. If your piston rod had stripped both threads what would you do?

5. In figuring the normal horsepower of a boiler, how is it that some say 10 sq. ft. and some 12 and 15 sq. ft. for horsepower?

6. What is the rule for figuring out the number of stays for a boiler? J. K.

A. 1. If lap is added to a valve the eccentric must be turned forward on the shaft in the direction of its rotation enough to bring the admission of steam at or a little before the beginning of the stroke.

2. The horsepower developed in the steam cylinder of a boiler feed pump is figured in exactly the same way as for any other steam cylinder, viz., multiply the average effective pressure, called mean effective pressure, by the area of the steam piston in square inches to get the total pounds force acting on the piston, then multiply this by the distance that the piston travels in feet in a minute to get the foot pounds per minute. This distance will be the length of one stroke in feet, times the working strokes per minute. Dividing this by 33,000, the foot pounds per minute for one horsepower, gives the horsepower developed. In your case a 6-in. steam piston has an area of 28.27 sq. in., and the average forward pressure, assuming that the pump takes steam full stroke and the back pressure is 2 lb., would be 98 lb. The length of the stroke in feet is $10 \div 12$, so that the foot pounds would be $98 \times 28.27 \times 120 \times 10 \div 12$. Dividing this by 33,000 gives the horsepower 8.4.

3. In the case of a steam piston, if it insists on leaking, evidently either the steam piston packing is not correctly put in or the cylinder is out of true. If the piston packing rings are wrong, new packing rings must be put in. If the cylinder bore is out of true it must be rebored. Nothing else will do the trick. If it is the water cylinder which is leaking, the chances are that the packing is wrong and the first thing is to repack the water piston. If that doesn't do it, probably the water cylinder is out of true and must be rebored.

4. With a piston rod stripped on both ends, for the time being, it is well to get the nuts back on and rivet over the ends or put the nuts on and drill through and pin them in place. Or if everything else is in good condition, the ends of the rods could be turned down smooth and a collar turned up to fit over these, and bear on the pistons, and tap bolt tapped into the end of the piston rod, and a washer used to hold the collar up against the piston head. Make new rods as soon as possible, because any such expedient means a weakened end to the piston rod, which soon or later is likely to give way and cause trouble.

5. The difference in square feet of heating surface allowed per horsepower of boiler is due simply to the difference in activity in different types of boilers. For instance, with the cylindrical or flue boiler, the surfaces are not very active and 15 sq. ft. is necessary. Where ample capacity is wanted this allowance is also sometimes made for horizontal tubular boilers. With modern construction, however, the horizontal tubular boiler and the water-tube boilers are usually expected to give a boiler horsepower for 12 sq. ft. of heating surface, and water tubes will give a horsepower from 10 sq. ft. of heating surface.

The boiler horsepower is rated primarily on the

evaporation of 34.5 lb. of water per hour from and at 212 deg., which amounts to about 30 lb. an hour under average running conditions, and the number of square feet heating surface to be allowed for a boiler horsepower is simply the number necessary to evaporate this amount of water per hour.

6. Rules for figuring out the number of stays for a boiler are rather complex and cannot be given in the limits of a letter. The Board of Boiler Rules, State House, Boston, Mass., has compiled a full set of rules and tables for figuring the staying in a boiler which may be secured by writing to the address given.

Location of Engine

Would you please let me know which would be the more economical to have an engine 60 ft. from the boiler house and have a short rope drive or to have an engine in the boiler house and have a long rope drive? The engine would have to be in the basement of the factory for a short drive and for a long drive it would be in the boiler house. Would there be more loss of power to have the engine in the basement of the factory or in the long drive? P. H.

A. There would not be much choice of the loss, provided both constructions were of the best. If the engine is put away from the power house, the steam-pipe must be carefully insulated to prevent heat loss. If the engine is put in the boiler house the guide pulleys must be carefully arranged to give the least possible friction on the rope drive.

This becomes more a question of cost and convenience than of loss in power. The matter of cost will depend on the amount of power to be transmitted, and the conditions over which the drive has to run, but for moderate power the long drive should cost more than the long steam pipe. Against this there is the inconvenience of having the engine away from the boiler house, where it will require running back and forth to take care of the plant, and the bother of having it in a basement instead of a light room. If, however the engine is placed in the boiler house, there is the difficulty of keeping up the long drive and, of course, the cost of repairs and replacement. A problem like this can only be solved by making some fairly accurate figures for the particular case in consideration.

Proper Gas Mixture

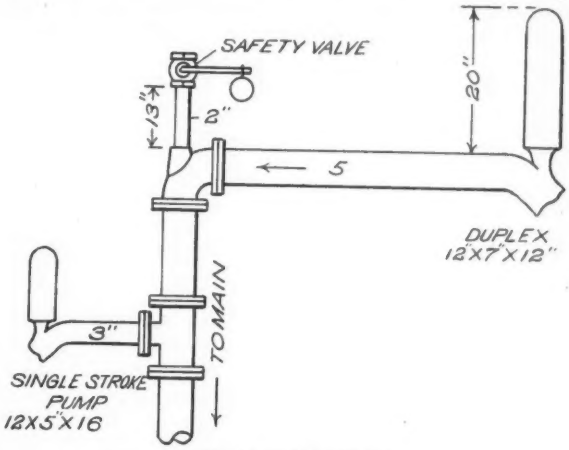
I am operating a Westinghouse, 500-hp. tandem, double acting gas engine. When I have excessive back firing I cut the air down and it stops. I would like an explanation why that is so. I think my backfiring is caused by too strong gas, for when I have weak gas I never have backfiring. I would like other engineers operating this type of engine to give their experiences in Practical Engineer, as there are several other matters I would like to discuss. E. D. M.

A.—The back-firing is caused by having the compression too strong for the gas. The weaker the gas, the stronger the compression can be used. When you are using a rich gas, if you supply too much air you get a mixture which will explode at a lower compression than when the air is just sufficient to burn the fuel after it is ignited.

Leaking Water Main

I enclose rough sketch of our pump connections to the mains. These pumps run smooth and without a pound when run separately, supplying the city at a pressure of 35 to 40 lb., but when run together during fires with a pressure of 100 lb. or more they pound so badly that one would imagine they would go to pieces. After each fire we have to dig up and calk from 3 to 5 joints where the lead has worked out. Leaks always occur in the 8 in. main leading from plant; 4 and 6-in. mains do not give us any bother. At a fire recently we carried 100 to 110-lb. pressure on 4 lines of hose. After the fire we found 4 leaks, caused as usual.

The officials blame us; say we carry too much pressure; we claim poor calking and pump pounding causes the pipes to vibrate, causing lead to work loose and of course pressure will push it out when loose. On several occasions we have asked for a piece of 6-in. pipe and fittings to place where safety valve is on the pipes to act as an air chamber and believe it would stop some of the pounding, but we received so little support in this matter from those we work under, light and



PIPING FROM PUMPS

water commission, it was allowed to drop. This time the change will be made if we have to scrap for it. I would like an answer to the following questions:

1. Would a piece of 6-in. pipe placed where safety valve is, to act as an air chamber reduce pounding in the pumps; this would be connected by a 2-in. nipple?

2. How long a pipe would you advise putting in?

3. Would the vibration of mains help to cause leaks? S. C. W.

A. Unquestionably putting on an air chamber at the place where the safety valve is now attached would relieve the pounding.

2. The length of 6-in. pipe to use for this purpose is largely a matter of guess work. As it has to carry a high pressure at times when the pumps are being driven hard, it will pay to use plenty of space. If you get it too large it is easy enough to let part of the chamber fill with water, while if you get it too small it will not accomplish much in the way of stopping the pounding. A rule given by Suplee is that the air vessel should be from 3 to 6 times the capacity of the pump on the delivery side. This would mean that the air chamber on your proposition, using an average allowance, would have a volume 4 times that of both pump cylinders, or 3100 cu. in. The internal area for a 6-in. pipe is about 29 sq. in. To get 3100 cu. in. you would then have a pipe 107 in., or 8 ft. 11 in. long.

3. Undoubtedly the vibration of mains will help to cause leaks and the pounding of the water column in starting and stopping will also tend to drive the calking loose.

Amount of Cylinder Oil

In a recent issue appeared an inquiry regarding the proper lubrication of steam engine cylinders. This

prompted an inquiry on the amount of oil that should be used in gas engine lubrication.

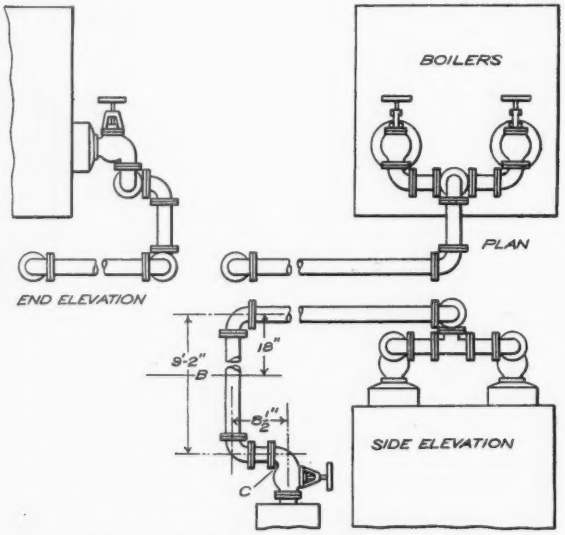
We have an 85 hp. single cylinder, horizontal German type Olds gas engine. The 18-in. piston travels 800 ft. per minute. We are running on natural gas and keep the water for cooling at about 168 deg. F., leaving the water jacket. Our present practice is 1 drop of best gas engine cylinder oil for each 4 ft. of piston travel. Is this in accordance with best practice? H. H. V. K.

Pipe Vibration

I saw the results of an engine wreck or rather a throttle wreck a few days ago, that has had me thinking ever since.

A horizontal engine belted to a generator, is well set on its foundation, and piped about as shown in the cut.

When the engine takes full load the pipe vibrates about 1/16 in. at B and broke the throttle valve close



STEAM PIPING FROM BOILER TO ENGINE.

to the flange at C. When the engine is running with ⅓ load or less, there is scarcely any vibration.

I would like to know how that vibration may be overcome or if it may be stopped by any other method than anchoring the pipe. K. W.

Splicing Wire Rope

Can any of the readers give me instructions for splicing a thimble onto a 6-strand hoisting wire, making the instructions as definite and detailed as possible? H. W. C.

Paint for Ice Storage Rooms

What kind of paint will be suitable for resurfacing my ice storage rooms, the walls of which are in bad shape? These must be renewed next season, but we wish to have them hold over this year if possible. Also, when installing the new walls, what is the best finish for the surfaces, something which will resist the action of the moisture and be easily kept clean? C. I.

The Capacity of a Centrifugal Pump

I have a pump with 4 runner arms, each 3 by 3 by 10-in., the shaft hole is 2.5 in. diameter and the pump runs at 350 r. p. m. The lift is 24 ft.

Can any reader give me a method of figuring the number of cubic feet of water that this pump will handle in an hour, and how much horsepower will be required to run it? F. P.

HOISTING ENGINEERS' QUESTIONS

By Andrew Flesher

Q. What are the necessary qualifications to become a reliable hoisting engineer?

A. He should have a good character, a stern determination, and be full of pluck, industrious and reliable at the throttle, for the trust of life and property is in his care; he should not at any time yield to intoxicants, as intoxication will ruin any man and be the cause of having his certificate revoked.

Q. What are the duties of a hoisting engineer on entering the engine room for the hoisting shift?

A. He should close the engine-room door and allow no one to enter, and see that the night engineer has the pumps, boilers, engines and engine room in good condition for the day's work.

Q. After examining the daily report book, and the night engineer reports all in good condition, what is his next duty?

A. Blow the whistle for the men to be lowered into the mine on time, step to the throttle and run the empty cages up and down in the shaft until all the condensed steam is out of the pipes and cylinders before you allow the miners to get on the cage; see that the top man is at his post to examine the cages and ropes.

Q. Is it right for one hoisting engineer to start the engines and allow the engineer just coming on duty to relieve him while the engines are still in motion?

A. This is sometimes practiced but not the right thing to do. If the shaft is not very deep, and the engines are high-speed, there is great danger, the engineer taking hold may become confused and not get control of his engines until it is too late, then you will have one cage smashed into the sheave wheel at the top and the other battered to pieces on the bottom, causing great damage to property, and may be the loss of some lives. It is safer to have the engines standing while the engineers change at the throttle.

Q. How would you proceed to take an old cable off the drum and put a new one on?

A. Place the cage that is attached to the cable to be removed at the ground landing on timber and block it safe; the engineer must now slack his cable so that it can be uncoupled from the cage chains; after it is uncoupled a rope must be tied to the end of the cable that is long enough to allow the cable to pass up over the sheave wheel and down to the ground; here the blacksmiths take the clamps off the cable and fit up a new set for the new cable.

The top men will now place an old cable spool in front of the drum and proceed to wind the old cable on the spool, while the engineer operates his engines, slowly unwinding the old cable off the drum, and by the time the cage on the opposite cable has traveled from the bottom of the shaft to the top dump, the old cable is within 2.5 laps of being off the drum. The top men take their wrenches and go into the drum, take the clamps off that fastens the old cable to the drum, and take the remaining 2.5 laps off by hand and finish winding it up on the spool. Then remove the spool with the old cable and place in its place the spool with the new cable, take the end of the new cable into the drum and place 2.5 laps on the drum, and clamp it there secure.

The engineer will now operate his engines, slowly

lowering the cage back to the bottom and winding the new cable on the drum while the top men keep it in its proper travel or grooves. When the cage has reached the bottom the top men will finish unwinding the remaining cable left on the spool, and measure the distance from the drum up over the sheave wheel and down to the cage chains, less the distance from the cage at the ground landing to its extreme travel at the top.

At this point the blacksmiths will set the clamps or fasten the socket, then the small rope is tied into the socket or clamps and the top men proceed to pull the end of the cable up over the sheave wheel down to the cage chains and fasten with a clevis made of the best Norway iron. The engineer will take up the slack rope and the top men remove the timbers that hold the cage, and the new cable is ready for hoisting.

Q. Should the engineer have control of the firemen?

A. Yes; the engineer must have control of his firemen and see that they follow out his instructions, and he must instruct them to examine where the water is in the boilers and see that they are safe before placing a hot fire under them; that their safety valves are in good working condition, and examine the bottoms of the boilers to see if there is any leaks or blisters, and notify him at any time if something should occur in the boiler room they do not understand.

Q. Should the engineer have control of the pumps in the shaft?

A. He must have charge of all pumps connected to the battery of boilers under his care.

Q. Must the fireman talk to the engineer when the engineer has the engines running?

A. He should wait until the engineer has landed his cage before speaking to him, and the engineer must be sure he has received the proper signal before starting his engines again; avoid conversation as much as possible.

Q. Say we have a shaft 500 ft. deep, how would you put in a 2-in. steam pipe line from top to bottom of shaft for the sump pump?

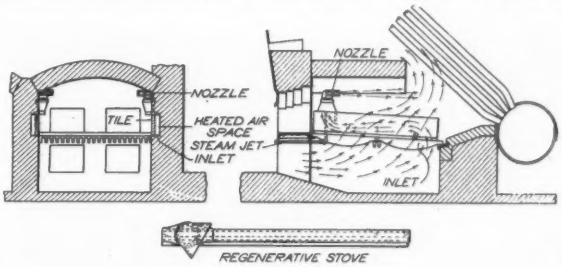
A. We will uncouple the hoisting cable from the cage, leaving the cage at the lower landing; take one length of pipe and start it down the shaft in about the place you wish to have the pipe line remain; have a sleeve on the top end of the pipe, place a clamp just under this sleeve, the clamp to rest on the timber and the sleeve will keep the pipe from slipping through the clamp; take the second length of pipe, place a sleeve on the top end, and in this sleeve have a short 2-in. nipple, on this nipple put a 2-in. tee on side opening, connect this tee with a swivel clevis on the end of the cable, the engineer will hoist the length of pipe up until it stands perpendicular in the shaft, take pipe tongs and connect this length with the length that has the sleeve resting on the clamp that is supported by the timbers, screw it up so it will not leak with a pressure, the engineer will take the weight of pipe on the cable, and the clamp under the sleeve can be removed, then the engineer will lower the pipe one length, and the clamp will be replaced under the second sleeve, and the nipple and tee taken out and connected to the third length in like manner, and so on until the bottom of shaft is reached, thus making it perfectly safe.

To FIND THE CYLINDER ratio for two cylinder engines, multiply the absolute initial pressure, which may be taken at 5 lbs. less than the boiler pressure, by 4.5 and divide by 105. The quotient will be the cylinder ratio.

PARSONS SYSTEM OF COMBUSTION

Complete combustion is obtained in this system by passing additional air through regenerative stoves of the proper design and so located that the bed of fuel heats the incoming air to the kindling temperature of the gases. The air is then projected into the gases which are distilled from the bed of burning coal in such a manner as thoroughly to intermingle and cause perfect combustion, thus eliminating smoke and effecting a great saving in fuel.

Referring to the illustration, it will be seen that in each boiler furnace there are 2 of these regenerative stoves. These are placed along the sides of the furnace just above the grates, and extend the full length of the grate. The regenerative stoves themselves are made of cast iron and steel, but are protected from the heat of the furnace by tile. The air



PARSONS DRAFT SYSTEM

inlet to the regenerative stove is at the rear of the furnace, directly adjacent to the bridge wall, and the outlet is at the front, through the nozzles which are placed at such an angle as to secure a thorough mixture of the heated air with the volatile gases. A jet is provided in which either compressed air or steam can be used when the furnace is starting up, and to give additional draft through the regenerative stoves, the volume depending upon the amount of coal consumed. The air supply is drawn from the ashpit; in other words, the same source of supply from which the air which passes through the grates is obtained.

Two tests were made upon a 300 hp. Stirling water tube boiler in order to compare the results obtained by using the Parsons system of combustion, with the results obtained without the system. During the test without the apparatus the draft pressure maintained in inches of water was 0.34, against 0.5 when the system was employed. The highest furnace temperature obtained without the system was 2,500 deg. F., which was raised to 2575 when the system was employed. The most remarkable feature of these tests was that during the time the boiler was operated without this additional supply of air the evaporation per pound of dry coal from and at 212 deg. F. was 8.86 lb. of water, while during the other test this was increased to 11.61 lb. The boiler horsepower developed on the basis of 34.5 lb. of equivalent evaporation per hour was 217 against 237, in favor of the Parsons system. From these tests it is determined that a net saving of 20.2 per cent in the amount of coal used was made possible by the use of this system of complete combustion.

The installation of this system can be made at such a reasonable cost that it is not a burden to manufacturers; and it can be placed in most furnaces without any change whatever in the brick work or grates.

Consider this day your doomsday and learn how valuable it can be made.

CHICAGO ELECTRICAL SHOW

AT THE Fifth Annual Chicago Electrical Show held in the Coliseum from Jan. 15th to 29th, more attention was given to the domestic application of electricity than to the power plant equipment. As a result, only a few of the manufacturers of large power plant apparatus were represented.

The exhibits of vacuum cleaners, fan motors, lamps, cooking utensils, electrical heaters, electrical signs, electrically operated tools, storage batteries, carbon products, etc., were numerous.

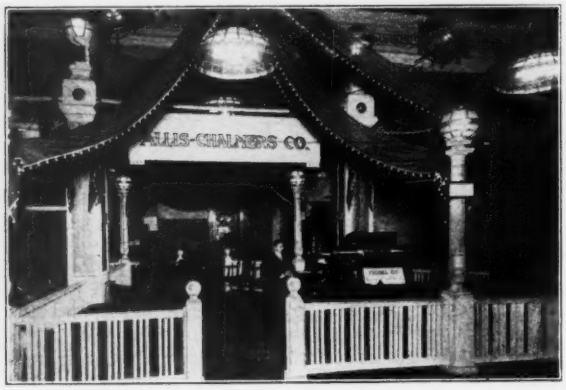
The Allis-Chalmers Company of Milwaukee, exhibited a line of lighting transformers ranging from 10 to 50 kw. capacity, suitable for service on poles for transforming from 2,100 or 1,050 volts to 220 or 110. A model of a Parsons horizontal steam turbine, with a portion of the case removed to show the working parts, was exhibited in this booth, illustrating clearly the construction, and many good features of this high-pressure turbine. There was also on exhibit in this booth a 30-hp. 3-phase induction motor and a potential starter. A portable air compressor which is operated by an alternating current motor built for 3-phase current at 115 volts, 60 cycles, attracted considerable attention.

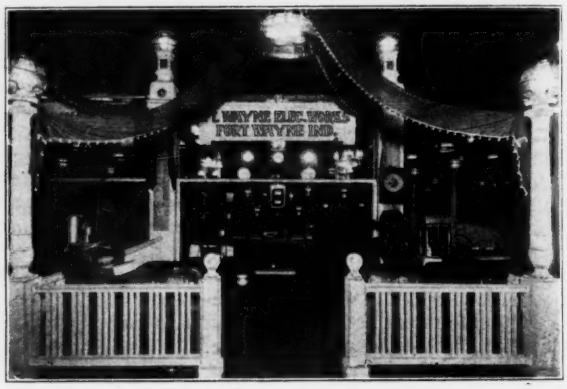
The exhibit, under the direction of C. A. Tupper, was placed in charge of F. G. Bolles, who was assisted by J. W. Gardner, Chas. M. Howe, S. R. Kerr, C. S. Buell, A. W. Catlin, K. D. Chadbourne, J. M. Denniston, Erwin Dryer, R. H. Gaither, C. M. McDonald, C. M. Nicholson, J. C. Orrell, L. St. John Smith, F. von Schlegell and E. W. Linquist.

In the booth occupied by the Fort Wayne Electrical & Mfg. Co. were exhibited a line of small motors, switch board instruments and meter transformers, series arc lamps, a Compensarc, and a small motor generator set. The Compensarc is one of the recent developments of this company and is used for regulating alternating current in connection with moving picture apparatus, thus doing away entirely with the rheostat. The motor generator set which was exhibited, is for the same purpose as the Compensarc except that is is wound for direct current and automatically regulates the current which is furnished to the arc lamp with such success that even in the case of a short circuit, no harm is done to the motor generator set.

An Ozonizer, which is the product of the National Air Filter Company, was also exhibited in this booth. This apparatus is used for purifying air in large buildings such as libraries, convention halls and the like, giving the air an odor similar to that upon mountain tops. To show the application of small motors, there was exhibited a Paul pump, operated by the Ft. Wayne motor, by means of a worm gear, which is used where a small amount of water is needed. L. A. Carr had charge of the booth and was assisted by A. L. Pond, A. J. Francis, H. Plumley and A. E. Stevens, all representatives of the company.

The General Electric Company occupied one of the large booths and displayed a line of heating devices consisting of coffee percolators, toasters, flat irons, chafing dishes, water heaters, luminous radiators, cigar lights, etc. A motor-driven breast drill and also a sewing machine were among the attractions in this booth. The most complete line, however, was that of lamps, the booth being lighted by the latest product in this line, the G. E. Mazda, which embodies the most recent developments in high efficiency metal filament lamps. The Mazda lamp is designed to take the place of carbon filament lamps which is used in residences, stores and for sign purposes. The booth also contained 3 ornamental intensified arc lamps; 1 9-ampere luminous arc lamp, which is used principally for street lighting; 2 12-ampere and 2 18-ampere flaming arc lamps, which are adapted for store and office use where color distinctions are important; G. E. Mazda, and tantalum lamps of different sizes and capacity; 2 lamp cabinets displaying a complete line of miniature lamps and a photometer for showing comparative tests of G. E. Mazda and carbon lamps; a complete line of cabinet panels and wiring devices; also, lamps for automobiles were on exhibit in this booth.





BOOTHS AT THE CHICAGO ELECTRICAL SHOW

F. H. Gale, of Schenectady, was in charge of the exhibit and was assisted by W. H. Colman, J. H. Cross, F. T. Benson, C. M. Axford, Louis Friedman and other representatives of the General Electric Co.

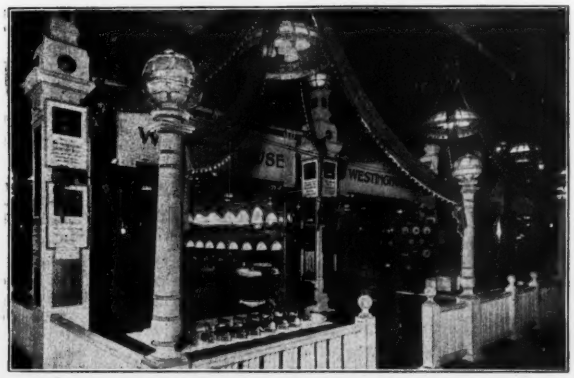
In the Westinghouse booth were displayed representative pieces of apparatus as manufactured by the Westinghouse Electric & Mfg. Co., Westinghouse Lamp Co., Westinghouse Storage Battery Co. and the Cooper-Hewitt Co.

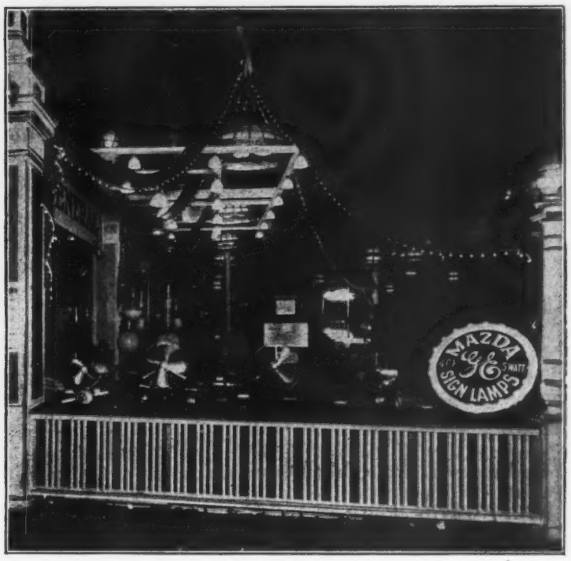
The Westinghouse Electric & Mfg. Co. showed a line of its smaller pieces of apparatus, such as the smaller sizes of its "CCL" type "S" and type "R" motors, also its type "A" and "MS" motors with the controlling apparatus for the different types of motors. A complete line of smaller a.c. and d.c. power motors, as well as buffing motors was shown. Several types of the latest lightning arresters were shown, as well

as the spark gaps and auxiliary parts for use in connection with these arresters.

A complete representation of its switchboard meters, integrating motors and a good display of precision and portable instruments for various classes of service were on exhibit. One of its latest type "A" controllers for use in heavy steel mill service was shown in operation, as well as a type "A" automatic mercury rectifier connected with one of its automobile charging panels.

The company also had on exhibition a complete display of fan motors, including 12 and 16-in. oscillating, wall and desk fan motors and a variety of 8-in. fan motors with the different and attractive kinds of finish in which these motors are manufactured.





BOOTHS AT THE CHICAGO ELECTRICAL SHOW

Among the household devices which this company manufacture was shown a complete line of its Toaster stoves, Disc stoves, coffee percolators, hot water heaters, chafing dishes, and different sizes of family sad irons.

The Westinghouse Lamp Co. had an attractive rack upon which were burning several of its low voltage tungsten lamps, connected in circuit with an economy coil. There were also shown on this rack, in operation, samples of its 110 and 220-volt tungsten lamps ranging in size from the 250-watt to the smallest.

Various types of lamps were shown, among which were its street series lamps, special advertising lamps, sign lamps and miniature lamps.

The Westinghouse Storage Battery Co. which recently took over the business of the General Storage Battery Co. exhibited samples of its pure lead Westinghouse Plante plate and Bijur Plante plate with alloy grid. It also displayed its new pasted plate for electric vehicle work which has just been placed on the market.

The Cooper-Hewitt Electric Co. displayed several sizes of its mercury vapor lamps and had some attractive literature describing the desirable features of these lamps for use in buildings where it is necessary to avoid sharp shadows and where good general illumination is desired at little cost of maintenance and where current consumption forms an important factor.

Among those in attendance at the exhibit were the following representing the different companies: representing Westinghouse Electric & Mfg. Co. were: T. P. Gaylor, Mgr. Chicago office; W. R. Pinckard, A. L. Millard, R. H. Moore, E. M. Bischoff, C. W. Regester, J. W. Busch; representing Westinghouse Lamp Co. were: J. M. Schilling, Mgr. Chicago office; A. N. Brown, C. R. Wood; representing Storage Battery Co. were: Jno. L. Jones, Mgr. Chicago office; Wm. N. Brown, N. G. Thompson; representing Cooper-Hewitt Co. were: Irving B. Cary, Mgr. Chicago office; Geo. W. Keech, G. R. Clover. W. Barnes, Jr., representing Westinghouse Bureau of Publicity, Pittsburg, was in charge of the exhibit.

IN A TEST recently made by F. W. Dean of Boston on a 60-in. tubular boiler 20 ft. long and having 55 3.5-in. tubes giving 1112 sq. ft. of heating surface and 21.5 sq. ft. of grate, it was found that a horsepower was obtained from 7.7 sq. ft. of heating surface, and 6.73 hp. from a square foot of grate surface with not over 0.25 in. of draft. The boiler was 24 yr. old; no change had been made in the tubes nor had they been cleaned on the water side.

Other tests on a 90-in. boiler 20 ft. long with 258 3-in. tubes showed a horsepower for 6.39 sq. ft. of heating surface hand fired and for 5.43 sq. ft. fired with B. & W. chain grate stokers.

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NEW THOUGHT IN THE NAVY

It is always interesting to find what have been the latest ideas among the officers of the Bureau of Steam Engineering, and the report of the Chief is the bulletin for that news. From the report for 1909 it is learned that for the battleships Wyoming and Arkansas water-tube boilers are to be used fitted for burning both coal and oil separately or together, while for torpedo boat destroyers, oil fuel only is to be used, with fan blowers for forced draft.

Ash ejector systems are to be installed on all the armored vessels. The main engines on several boats are to be changed from in-turning to out-turning. Standards have been worked out and adopted for flanges, small valves, throttle valves, and some work done on standards for pressure and cylinder volume for engines.

Repairing is the main work of the yards, but it is interesting to note that 43 launch engines were built at the Portsmouth, N. H., yard during the year, and 8 engines at the Mare Island, Cal., yard.

Interesting experiments are being conducted at the Annapolis Experiment Station as to the performance of condensers. A Blake apparatus has been tested with different conditions of vacuum and steam admitted, and other tests are being made with baffle plates inserted to give a contra flow effect. An Alberger condenser designed from the same data as the Blake will also be tested, thus giving data on the comparative performance of the 3 types.

Use of CO_2 apparatus has shown its value for testing the skill of a fireman, but it has proved that with the best of men several 4-hr. watches are needed before they can get the best results from a plant.

Investigations have been started on lubricants, packings, water gages and bearing metals, but these as well as equipment for other testing have been delayed because of lack of appropriation of funds. As important data will be secured not only for the navy but for all steam users, it is unfortunate that the Experiment Station is not given the needed support by Congress.

Gas engines, while not adopted as yet, are recommended for trial, a bituminous producer being used as the source of the gas. Gasoline is used, however, in launches, and comparative tests of 2-cycle and 4-cycle engines are soon to be made.

The system of education at Annapolis is commended by the report as "the best technical education furnished by any school in this country," and then they get 5 yr. service on deck and in engine room on board ship. Is it any wonder that those officers who decide to leave the navy are sought for important engineering positions?

Design has been recognized as a special branch and plans are now under way for a school of marine engineering in which such officers as are needed for the work will be given a course to fit them for designers of naval vessels and machinery.

OUGHT MAGAZINES TO COST MORE?

Through the newspapers and weekly periodicals the effort which has been made to ascertain the reason for a large deficit in the post office department has been given wide publicity. Secretary Hitchcock, taking the report made to him by a committee, stated that the cost of handling magazines has been 9 cents a pound while only 1 cent is paid as postage. Can this be true?

If magazines were handled by themselves, the cost could be definitely stated, but they are handled by the same clerks that handle letters, parcels, circulars catalogs and merchandise; they are shipped in the same cars, wagons and boats. It is therefore a matter of difficulty to apportion the cost of such handling and transportation, and any figures given should be examined to see how they were derived.

Within the memory of the present generation, magazines were sold net, and the subscriber paid the postage. Evidently the present method of prepaid postage is more convenient and satisfactory. It would be unfortunate if return to the old system were made necessary, or if, on the other hand, a large increase in postage cost made necessary increase in the subscription rates for periodicals.

On examination, however, it does not seem that such increase should be necessary. It is true that the second class mail, which includes periodicals and newspapers is by far the greatest weight in the mails, but it does not seem that it should be charged with expense in all departments proportional to the weight. For instance, all second class matter is delivered to the post offices or to trains by the publishers and a large part of it is in sacks ready for forwarding to destination without sorting. Second class mail can be shipped as well by slow trains as by fast ones and the subsidy for extra fast mail service desirable for letters should not therefore be loaded on periodicals. On many expensive routes a minimum payment is provided for carrying mail regardless of how little is carried, and the weight shipped does not come up to that which calls for extra payment, hence the addition of the second class mail brings no added cost for carrying. Daily rural delivery service is not needed by periodicals, yet for rural delivery which has been adopted as a government policy regardless of the fact that it is a losing proposition, a big charge is made against second class mail. Weight of sacks constitutes only 5 per cent of the second class mail while for other classes the sacks often weigh 2 to 10 times the weight of the actual mail carried.

In view of these and other similar facts, does it seem good sense to charge the cost of different departments of the post office service to classes of mail in proportion to weight carried when much of the expense is due to certain government policies which would be carried out if there were no second class mail.

G. W. Wilder has made a careful analysis of the figures given in the department reports and finds first that second class mail which is paid matter, as distinguished from free matter, is only 32.4 per cent of the total mail instead of 36.4. There is evidently no reason why that periodical mail which pays should be burdened with the expense of mail which as a matter of government policy is carried free; but this seemingly small error makes a difference of $7,000,000 in the expense charged to handling magazines.

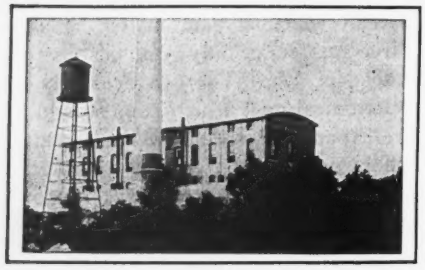
Mr. Wilder's analysis similarly takes up the different items charged against second class mail and shows that on the whole some $62,669,595 has been allotted as a second class mail expense which would be there just the same whether magazines and periodicals were carried or not.

As to the real effect which second class mail has on the postal deficit, the following facts are illuminating: In 1870 when there was no pound rate for periodicals the deficit was 21.4 per cent of the expense of the post office department; in 1880, the first year at pound rates, the mail increased largely but the deficit was only 9.6 per cent; in 1885 the rate on pound matter was cut in half and the amount of such matter trebled from 1880 to 1890, but the deficit dropped to 8.8 per cent. Up to 1900 the second class mail increased from about 174 million pounds to 382.5 million pounds and the deficit dropped to 5.2 per cent. In 1902 with 488.2 million pounds carried the deficit fell to 2.4 per cent.

At that time by the introduction of the beneficent rural delivery system a new expense was incurred and this has been rapidly increased by extensions and perfection of delivery. In 1907 the department deficit was $6,653,283; in 1908 owing to modifications of the postal regulations the periodical mail decreased 18 million pounds but the department expense increased $18,000,000 and the deficit increased proportionately. In 1909, while the amount of second class mail was only 2 per cent more than in 1907, and the department income was $19,977,378 greater than in 1907, the deficit increased to $17,441,719.

The records do not, therefore, seem to show that increase in second class matter is a direct cause of postal deficit.

Practical Engineer does not wish to be a pensioner of the government, and we feel sure that other periodicals are in the same attitude. Bookkeeping charges are, however, a matter of judgment, and it doesn't seem fair that the papers which are working to help the country and their readers should be charged with the cost of special service which the government establishes in the interest of the people when that service is in no way needed for the papers. We want to pay the reasonable cost of delivering the papers, but we believe that our readers will agree that this cost should be carefully determined and should be the actual reasonable cost, not complicated by the addition of high priced service adopted as a matter of governmental policy.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

THE NEW SELLS ROLLER BEARINGS

A great deal of interest is manifested in a new roller bearing being marketed by the Royersford Foundry & Machine Co. John D. Sells, the inventor of the bearing, for whom it is named the Sells roller bearing, has been for years identified with the Standard roller bearing, therefore the new Sells is the product of long experience and a comprehensive knowledge of the exacting requirements of roller bearings.

The Sells roller bearings are universal in adaptation. Any bearing of a given size can be fitted to any hanger, post hanger or pillow block of a corresponding size, either for new installation or for substituting in a plank previously equipped with the old style of plain or self oiling bearings.

This substitution for old style bearings can be made easily with the Sells without moving the frames or anything on the shafts as they are split, making them just as easy to apply as a split steel or wood pulley. This feature is an equal advantage in the erection of new equipment.

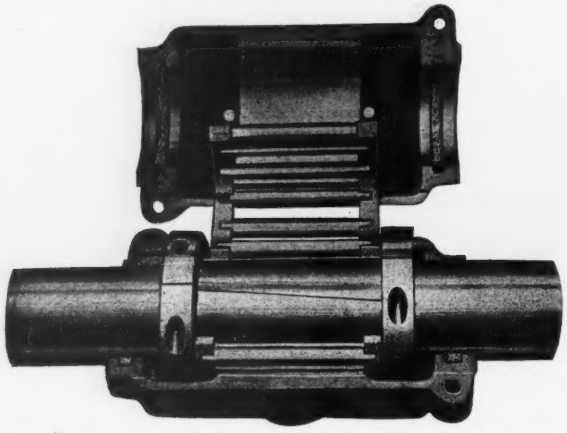


FIG. 1.—THE NEW SELLS ROLLER BEARING

Another advantage of this bearing is that all parts are interchangeable. In case any part of the bearing should become mislaid or broken by accident it can be replaced, saving the expense of ordering a complete new box.

Instead of allowing the rolls to run loose in the box, the Sells has a self contained roller structure; a split steel cage which holds the case hardened steel rolls equally separated from each other. This eliminates all the friction caused in the old style box where the rolls revolve against each other and also insures that the rolls will revolve parallel with one another and not diagonally with the box.

To prevent the shaft from being cut and scored by the case hardened steel rolls, the Sells roller bearing is fitted with a hard steel split bushing, clamped on the shaft by 2 split collars. This is obviously an economical feature, as bearings without this protection have often been known to cut the shaft so badly as to make it useless.

In order to increase the adaptability of the Sells and to broaden its scope of usefulness it is so constructed that these bushings can be varied in thickness that the bearings may be fitted to different diameters of shafts. This enables the user to change his shaft or adapt it to different bores as he desires. Each roller structure is susceptible to 3 such changes of bushings.

The steel split collars which clamp this bushing to the shaft also perform another important duty. Being fast to the shaft they rotate at a speed 3 times as great as that of the roller structure itself, and therefore provide a rotating surface for the ends of this roller structure to run against, aiding the latter considerably. As the illustrations show all end thrust friction is eliminated in the Sells bearing by its being of the full floating type.

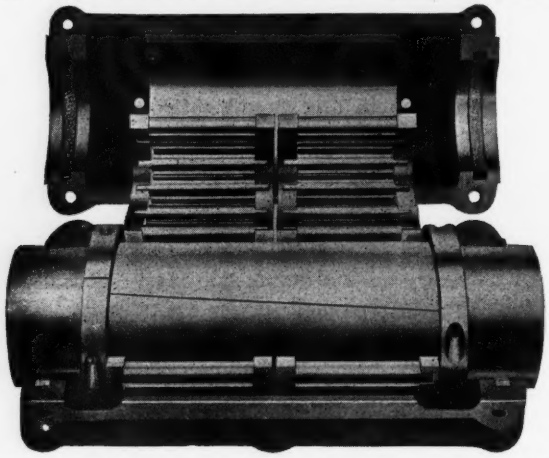


FIG. 2.—SELLS DOUBLE ROLLER BEARING FOR HEAVY SHAFTS

The 2 halves of the Sells bearings are fitted together by milled joints in order to make them dust proof. To further insure their being dust proof the manufacturer uses a heavy felt wiper at each end of the box which also serves the purpose of preventing oil from running out of the box. The box is also fitted with drain holes so that it may be flushed with kerosene oil or other cleansing fluid when the oil thickens or gums. Tapped holes on the top of the box provide for oil cups.

For head shaft or jack shaft purposes 3 11/16 in. or larger, a double roller structure is used so as to provide a longer and more suitable bearing surface for these heavily loaded shafts.

THE TENACITY OF GOOD new belt leather varies from 3000 lb. to 5000 lb. per square inch of sectional area or for single belts, 1000 lb. per inch width.

A NEW ENGINE STOP FOR CORLISS ENGINES

Mechanical engineers are well aware that all Corliss engines of the present day are provided with safety devices, whereby in case of the breakage of governor belt and the dropping of the governors the steam is shut off from the cylinder.

With all these devices it is necessary to provide means of holding up the governor at its point of maximum cut-off when the engine is shut down. This is usually done by the attendant throwing a stop in position just before shutting down, which should be removed when the governor rises again.

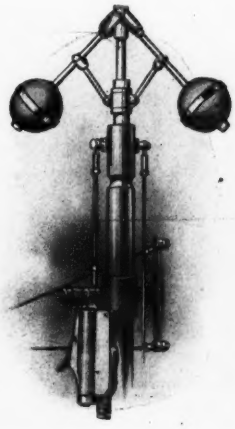


FIG. 1. SINGLE'S AUTOMATIC ENGINE STOP ATTACHED TO GOVERNOR

FIG. 2. SINGLE'S AUTOMATIC ENGINE STOP AND OVERLOAD CONTROLLER

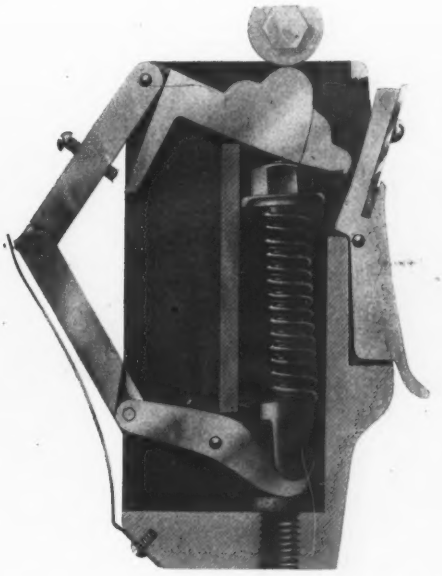


FIG. 3. SECTIONAL VIEW OF ENGINE STOP AND OVERLOAD CONTROLLER

When heavy overloads are met with, there is a great liability of the governor dropping below the point of maximum cut off, thereby bringing the safety device into action and shutting down the engine.

It is on account of this condition that the engineer frequently leaves in the stop pin, or fastens the device, what ever it may be, in position while the engine is running, in spite of the possibilities of disaster to the plant in the event of the governor belt breaking, or the stopping of the governor.

To guard against such a condition, a safety device was invented, known as the Single's Automatic Engine Stop and Overload Controller which may be placed under the crosshead or parallel rod of the governor as shown in Fig. 1. This device really combines 2 different functions. When the engine is at rest, and lever at the right in Figs. 2 and 3 is in position as shown in Fig. 2 it holds the governor in position of maximum cut-off, and when the engine is started up this lever drops, automatically putting the engine in safety position. In the event, however, of the governor belt breaking, and the entire weight of the governor coming down upon the device, it compresses itself, as shown in Fig. 3, allowing the governor to drop below its position of maximum cut-off, putting the safety plates in use and shutting the steam from the cylinder.

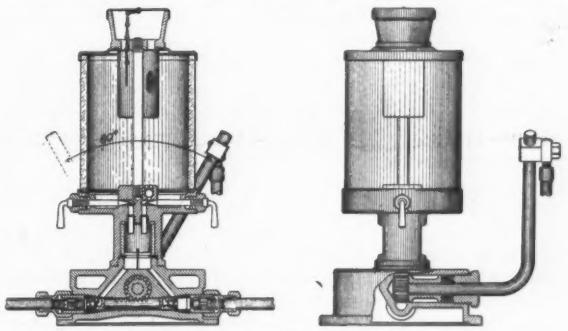
The intelligent engineer in charge of engines subject to heavy overloads understands thoroughly the danger in having the stop pin in his governor column, but he is absolutely forced to do so by the conditions of his load. To him the overload feature of this device will appear strongly, because with it he can carry his engine over peak loads sufficient to reduce the engine speed 25 per cent and at all times feel secure in the fact that in case of governor belt breaking his governor will drop into the safety position.

This is accomplished by adjusting the spring in Fig. 3 so that it will carry without collapsing the weight due to a decrease in speed of the desired number of revolutions. Any further weight due to the belt breaking and governor stopping will immediately collapse the spring and cause the lever to take the position shown in Fig. 3. This position of the governor will cause the safety cams to come into action and shut the steam from the cylinder.

Single's Automatic Engine Stop and Overload Controller is manufactured by Oscar D. Dillman, Hamilton, Ohio.

RICHARDSON OILING SPECIALTIES

The Model C, Richardson sight feed oil pump fills a constantly increasing demand for a small, neat and reliable, semi-automatic oil pump for small sized engines. It is nothing particularly new in general appearance, but



SECTIONAL VIEWS OF MODEL C OIL PUMP

in details of construction it is quite different and better adapted for use on small engines.

The pump is built with 1 or 2 feeds and with a sight glass tank, the capacity of which may be anything desir-

able. At the top is a large opening for filling, with a good strainer attached, and a substantial cover so fastened that it cannot be mislaid or lost. The feed valves are on the side of the pump near the bottom, convenient to get at and in plain view. The arrangement of the valve seats is such that dirt will not lodge upon them and an opening at the bottom is provided so that the valve can be cleaned easily.

In the base is provided a steel polished plunger, with a rack engaging gear on the combined shaft and lever, the latter being removable for adjustment at any angle by backing out the follower. To compensate for wear hard babbitt cones form the working chambers which can be compressed to renew the fit by forcing them in with the screw valve cases. Permanent tightness is insured by valve cases with hardened steel valves and beveled seats which can be reground.

The oil drops through an air tight, glass-enclosed chamber, in which the rate of feed is clearly visible. When the oil pump stops a small amount of oil will continue to fall forming the necessary excess for starting.

FIG. 3. RICHARDSON SIGHT FEED OILING SYSTEM

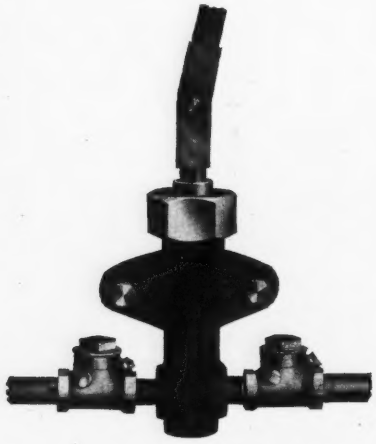


FIG. 2. THE RICHARDSON PLUNGER PUMP

The Richardson plunger pump is used where a plunger pump is desired which is simple in construction, will handle dirty oil which drains away from the cylinder bed and force it to the filter, and is durable so that it needs little attention. In this pump a piston, as shown, is operated from some part of the reciprocating motion and draws the oil through one check valve and forces it on to a second one. Pratt & Cady checks are used, which have a high grade of workmanship and are of such design as to be easily cleaned.

Another specialty is the Richardson oiling system sight feed, which is a device to be introduced at any point where it is desirable to watch the flow of the oil. These fittings are made for 1, 2, 3 or 4 pipe connections, using the Union Cinch joint, which is made by the Sight Feed Oil Pump Co. This takes ¼-in. iron pipe or the pipe openings may be, if desired, tapped for ¼-in pipe at the same price. The amount of feed through the sight feed fitting is adjustable, the valve stem being tightly packed against pressure.

These specialties are all manufactured by the Sight Feed Oil Pump Co. of Milwaukee, Wis.

NASON-VESUVIUS STEAM TRAP

To command and retain popularity the construction of the steam trap must be such that it can be understood easily by every practical mechanic, and it must of necessity be simple in design; all parts must be accessible and readily removed, and the design must be such that the trap requires a minimum of care and attention. These features are embodied in the Nason-Vesuvius steam trap.

It is an intermittent discharge trap in which the full area of the valve opening is maintained during the entire period of dischange, and the principle employed in opening and closing the valve eliminates the erosive action or scoring of the discharge jet, as the ball is entirely removed from its seat or rigidly held thereon.

The ball valve is positively regrinding, as a different surface is presented to the seat with each closure, insuring thereby positive action and durability of the seating surface under all conditions. The action of the tilting bucket keeps in motion any scale of foreign particles entering into the trap, thus preventing their constant discharge, without fouling the trap or impairing its mechanism.

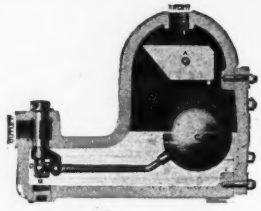


FIG. 1. NASON-VESUVIUS TRAP IN FILLING POSITION

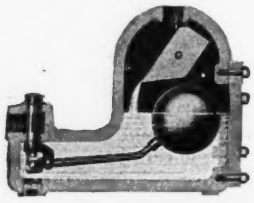


FIG. 2. TRAP DISCHARGING CONTENTS

When the trap is placed on the lowest point to be drained connection is made at the point marked inlet, the outlet being closed by the ball valve B. The incoming water is received in the copper tilting bucket A pivoted in the dome of the trap, the bucket being so balanced that when full of water it tips and empties its contents into the main body of water. The quick upward impulse imparted to the float seat by this discharge removes the ball from its seat and the instantaneous action of the ball leaving its seat allows a clear freeway for its discharge.

In closing, the float follows a receding water level and gradually returns the ball towards its seat until a predetermined level is reached. At this point the pressure picks up the ball and seats it, thus closing the discharge orifice until the above described operation is repeated.

A special catalog has just been issued illustrating and describing this trap, and copies may be had upon application to the manufacturer, Nason Manufacturing Co., of New York.

STURTEVANT FUEL ECONOMIZERS AND AIR HEATERS

Special features of more than usual interest, which are embodied in these devices, are described in the new catalog 150 recently received. The catalog itself is well worth possessing, and those who are at all interested in such apparatus will do well to write the B. F. Sturtevant Co. of Hyde Park, Mass., for a copy, but

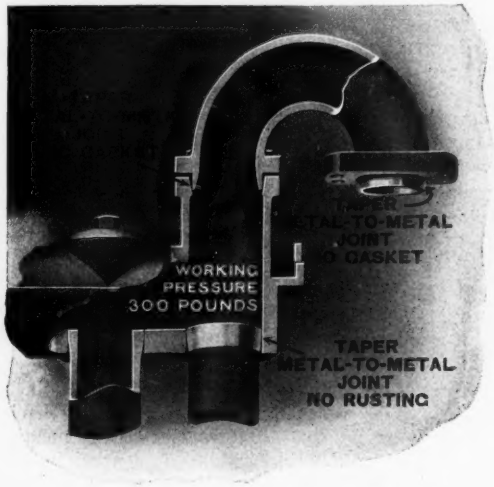


FIG. 1.—METAL JOINT CONSTRUCTION

the special features which attract attention are the metal to metal construction in the flange joints, and the special metal joints, by which the tubes are connected to the headers. These are shown in Fig. 1.

These joints are so carefully constructed that they will stand working pressures up to 300 lb. a square inch, and the desirability of avoiding the use of gaskets under the conditions which exist in an economizer with modern high pressures will be appreciated by all who have handled such joints.

Another cut of interest is that showing the travel of the hot gases around the economizer tubes. The gas coming from the vertical boilers is shown passing into the uptake, and around through the economizer against the tubes, which are staggered so that all parts of the tubes are useful, and then on the chimney. A bypass being provided at H, permits the gases to be sent direct to the chimney in case of needed cleaning or repairs to the economizer. The flow of water is from the bottom of the economizer tubes to the top, a pump F sending the feed water in at the bottom header, and the escape being through a pipe G, at the top.

The s raper mechanism and scrapers, which keep the economizer tubes clear from ash, are so designed and constructed that they cannot stick or bind, a point which greatly reduces the labor of caring for the apparatus.

Not only a description of the apparatus with full dimension tables is given in the catalog, but also examples shown of the savings from the installation of an economizer, so that operating engineers, managers, plant owners and all who have any occasion to use the economizer will find matter of interest in this new booklet.

LUBRICANTS AS BUSINESS BAROMETERS

"If you want to know how business is done, ask the lubricant manufacturers. The sale of lubricants is as sensitive a barometer of business as the quotations on the stock exchanges of New York, London, Paris and Berlin." This statement is made by Adam Cook's Sons, makers of Albany Grease. The volume of business done by this firm makes its opinion valuable in that it is based upon reports received by them daily from their agents all over the world.

Nineteen hundred and nine has in some quarters been regarded as somewhat of a dull year. With this view, Adam Cook's Sons does not coincide, however, its viewpoint being based upon its sales books, which reflect an unusually satisfactory and healthy condition of affairs, not only as concerns 1909, but 1910 as well. More than that, there is indicated a state of activity in not only one but in all branches of industry in that Albany Grease is used as a lubricant for all classes and kinds of machinery, from dredging machinery through to automobiles and motor boats.

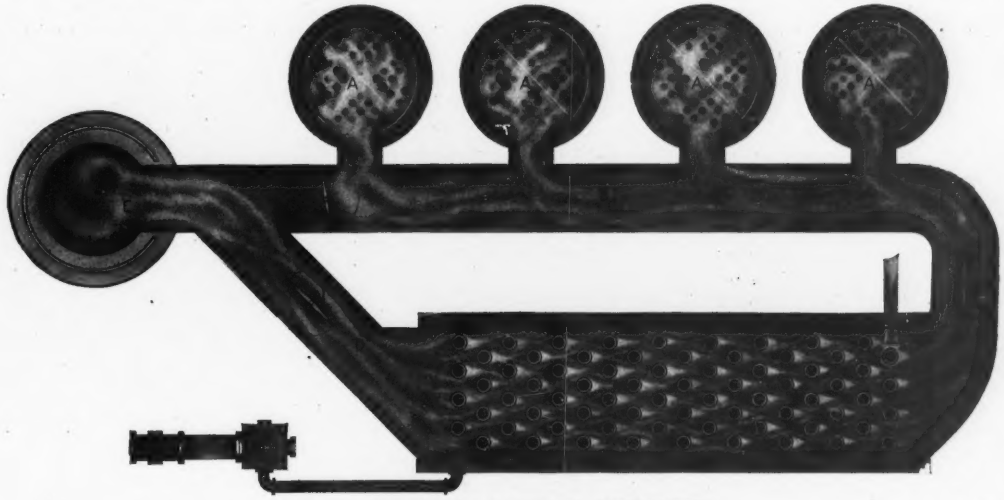


FIG. 2.—COURSE OF GASES IN ECONOMIZER

HORSEPOWER REQUIRED to raise water is found by multiplying the quantity of water raised in gallons per minute by 10, and by the height lifted in feet, and divide by 33,000. For losses due to friction and slip of valve, add ⅓ to ⅔.

NEWS NOTES

JOSEPH H. HART, formerly of the University of Pennsylvania, and A. C. Huseman have opened an office as consulting and contracting engineers in the Commercial Tribune Building, Cincinnati, Ohio, and will make a specialty of heating, ventilation, refrigerating and cooling towers.

F. A. HALL, WHO FOR the past 12 yr. has been manager of the Chain Block & Hoist Dept. of the Yale & Towne Mfg. Co., whose general offices are at 9 Murray St., New York, has resigned his position in order to accept election as vice-president and treasurer of the Cameron Engineering Co., of Brooklyn, N. Y. Mr. Hall's successor will be R. T. Hodgkins, who for several years has been his chief assistant, and who is thoroughly qualified by experience and ability successfully to perform the duties of the position. In his new connection Mr. Hall expects to make a specialty of trolleys and appliances for overhead handling of materials, and in connection therewith, to make use of the Yale & Towne blocks and hoists with the sale of which he has so long and prominently been identified.

CHAS. F. AMES ANNOUNCES that he has resigned as sales manager of The National Steam Pump Co., of Upper Sandusky, Ohio, and has opened an office in the Finance Building, Kansas City, Mo., where he will represent the Buffalo Steam Pump Co. and the National Steam Pump Co. He will handle a complete line of steam and power pumps and air compressors of every type, and solicits the continuance of the patronage of his former customers.

ON MAY 1 THE DEARBORN Drug & Chemical Works will move its general offices and chemical laboratories from the Postal Telegraph Building, where it has been located since the organization of the company more than 20 yr. ago, to the new McCormick Building, on Michigan avenue and Van Buren St. The extensive growth of the business of the company has made necessary this removal to its new home, where the general offices and laboratories will occupy the greater portion of the top floor of one of the finest office buildings in Chicago.

A. M. MORSE for the past 6 yr. district sales manager for Harrisburg Foundry and Machine Works, and who successfully introduced the Fleming-Harrisburg engines in Chicago and the Middle West, has resigned his position with that company. He will continue to maintain offices in the Marquette Building, 204 Dearborn street, where he has been located for the past 12 yr.

THE WILLIAMSPORT GAS ENGINE Works have reopened the plant of the Williamsport Gas Engine Company which has been shut down during the past year, and will continue the entire line of gas and gasoline engines formerly manufactured by the old company. They are looking for active agents in all sections of the country.

JOINT CONVENTION OF THE Southern Supply & Machinery Dealers' Association and American Supply & Machinery Manufacturers' Association will be held in Jacksonville, Fla., April 5, 6 and 7, 1910, with headquarters for both associations at the Hotel Seminole.

Application has been made for reduced railroad rates under the certificate plan. It has been suggested that following adjournment of the convention a number of the members of both associations may wish to make a trip through Florida, and then on to Cuba, provided arrangements can be made to have the tickets extended, and those desiring this privilege should notify Mr. Alvin M. Smith, secretary and treasurer Southern Supply & Machinery Dealers' Association, Richmond, Va., who will endeavor to make the arrangements.

ON FEB. 4 NEWARK, N. J., Association No. 3, N. A. S. E., held its 25th anniversary, entertainment and reception at the new Auditorium. Arrangements for the evening were in charge of F. R. Ehrhardt, chairman, Thomas A. Brown, Sec., and A. L. Davis, treasurer of the general committee, assisted by a number of efficient assistants. The early part of the evening was devoted to a concert and minstrel show, and after this the hours, until late in the morning, were devoted to the muse whose dwelling place is in the toes.

BUSINESS OF THE AMERICAN Steam Gauge & Valve Mfg. Company for January 1910, not alone greatly exceeded any previous January, but proves to be the biggest month's business ever done during the 60 yr. the company has been engaged in manufacturing power plant appliances. That this is a justification for all the preparations which the company has been making, with the conviction that 1910 would be a banner year, is strikingly corroborated by the character of this January business, as it consisted entirely in normal orders from every section of the continent.

THE PORCUPINE BOILER Co. has been organized to take over the business formerly carried on by the Connecticut Construction & Supply Co., and the works and office are now at Bridgeport, Conn.

THE ST. LOUIS STEAM ENGINEERS' CLUB of St. Louis, which was duly organized some few months back, has been holding very successful and noteworthy meetings at the club rooms of the Elks' Hall. At a previous meeting the following members were elected to office for 1910: Charles T. Parkinson, president; Otto A. Meltzow, vice-president; A. H. Herrin, secretary; P. D. Thompson, treasurer. The association has a membership of a little over 100, consisting of stationary engineers and salesmen of the allied trades. There is quite a number of applications for membership and, from all appearances, it will be only a short time when the present membership will greatly increase. At the last meeting of the association there were some important committees named in the way of entertainment committees. These committees are carrying out their respective duties to the entire satisfaction of the members and doing everything possible to further the interests of the association. From every indication, it is one of the best associations of this kind that has been organized and the stationary engineers and allied tradesmen will find it will be to their interest to become members of this instructive and progressive association.

A SERIES OF 20 lectures, given by non-resident lecturers, has been arranged for by the faculty of Columbia University to cover a course in works management. These lectures will be given at 4 p. m., Mondays and Thursdays, during the remainder of the academic year 1909-10. Those who will lecture on this course are Charles B. Going, Charles U. Carpenter, H. L. Gantt, Walter M. McFarland, Harrington Emerson, Richard T. Lingley and Edwin J. Prindle.

DUE TO FAST INCREASING business, both the Chicago and Baltimore branches of the H. W. Johns-Manville Co. have outgrown their present quarters, and about March 1st, both will move to new locations, with more room. The Chicago branch, now on Randolph street, will move to 27-29 Michigan Avenue. With 32,500 sq. ft. of floor space, offices, store and stock rooms will all be under one roof, with ample room for all. A full stock of J-M products will be carried, thus assuring prompt shipments. The Baltimore office, store and warehouse will be located at 30 Light Street. Here the company will have considerably more room than before, and will keep on hand a large stock of J-M products and will be in much better position than ever to give all orders prompt attention.

L. J. WING MFG. Co. has opened a company office in Chicago at 1765 Old Colony Building, where a stock of blowers will be carried. The office is in charge of J. J. Arnsfield, the western manager.

BOOKS AND CATALOGS

THE WILLIAMS MAGAZINE, February issue of which has just come to our desk, is a spicy little publication which makes pleasant reading and which you will read from one end to the other before you lay it down. It is written by David Gibson, a man who has at least one new idea every month and knows how to express it in an interesting way. The chief article in the February issue is a monologue on character study which treats of judging men and gives the specifications that a man ought to measure up against, how to determine the degree to which he possesses these qualifications, and on the side takes up the matter of monopolies and why they exist. Other issues which have appeared have taken up other lines of philosophizing, and all in all the magazine lives up to the statement made on the editorial page that it is "a magazine devoted to industry, commerce, humor and things in general," and that "the editorial expression is an effort at the real truth." The little booklet comes out each month and is published by the D. T. Williams Valve Co., of Cincinnati, O., and is sent for the asking to those within the business range of the company.

ELEMENTARY COURSE IN PERSPECTIVE by Sherman M. Turrill. 71 pages, 5 by 7.5 in., illustrated, cloth, 1910. Price $1.25.

A book for those who have studied some descriptive geometry and are, therefore, familiar with methods of projection. Two methods of making perspective drawings are treated, one by projection from plan and elevation views, the other by scale measurements. Both are fully discussed and illustrated by sample drawings and by problems. It is a clear and well written book for those ready to use it but is not adapted nor intended for those who have no knowledge of plan drawing and projection.

IN A PAMPHLET ENTITLED "Advertising and Its Service" the Geo. H. Gibson Co. has reprinted from the New York Evening Post an article discussing the economic theory of advertising, especially as regards the engineering and mechanical industries. It is shown that, contrary to current academic opinion, properly directed advertising reduces the cost of distribution of goods by providing the salesmen with a greater number of selling opportunities in a given territory and in a given time. The preliminary but necessary work of informing and educating the prospective user as to the nature, possibilities and profitableness of improved machinery, thereby hastening its adoption. Copies of this pamphlet may be had from the Geo. H. Gibson Co., Tribune Building, New York City.

CROWE STOKERS, STOKER engines and blower engines are fully described and illustrated in a neat catalog just issued by the Ironworks Co. of Jersey City, N. J.

MODERN WATER TUBE BOILERS is the title of a catalog just issued by the Milne Water Tube Boiler Co. This booklet illustrates and describes the construction of Milne water tube boilers and furnaces for which they are adopted.

"LET US FIGURE A LITTLE" is the title of an attractive folder being distributed by The Green Fuel Economizer Co. The folder is gotten up to represent a common school slate and tells of numerous textile mills where Green Economizers are producing large savings. The actual saving in dollars is clearly figured out for a typical plant and the computations set down in the form of a balance sheet showing convincingly the yearly net profit per horsepower to be obtained from a Green Fuel Economizer. This leaflet may be obtained by application to The Green Fuel Economizer Co., Matteawan, N. Y.

AMERICAN H_2O GREASE EXTRACTING Feed Water Filter for Marine and Stationary Engines, is the title of a recent booklet issued by the American Steam Gauge and Valve Mfg. Co., of Boston. These filters are placed directly in the feed line to the boiler, and employ filtering cloth wrapped around cages for removing all impurities from the water.

THE SCHAEFFER & BUDENBERG MFG. CO. has recently issued a handsome catalog describing its instruments of precision for measuring pressure, temperature and speed. These include gages for measuring the pressure of steam, ammonia, water, etc., as well as vacuum and draft gages and thermometers for all purposes.

THE GENERAL ELECTRIC CO. has recently issued the following bulletins which contain information valuable to any one interested in the power plant field:

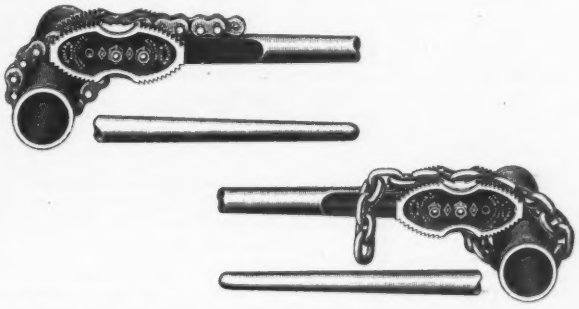
Publication No. 4707 entitled Gasoline-Electric Plants for Lighting and Power is an attractive pamphlet, which should be of great interest to those contemplating the installation of a small or isolated plant. As indicated by the title the pamphlet illustrates and describes complete generating units consisting of a direct current generator mounted on the shaft of a gas engine.

Bulletin No. 4713 describes the Type F, Forms K-2 and K-4 oil switches, states their rupturing capacities, contains diagrams of connections of these switches, and will be found of general interest to central station managers and engineers.

TRADE NOTES

J. H. WILLIAMS & CO., MANUFACTURERS of drop forgings, Brooklyn, N. Y., presents the climax of 25 yr. experience with chain tools in the "Vulcan-Bijaw" wrenches—"chips of the old block" in general utility. The reversible jaws, readily turned end for end when teeth wear, double the life and keep in readiness the service of the tools. The 2 studs or bolts through the handle prevent spread of the jaws when in use.

Material in the studs which fasten the jaws to the handle is of especially great strength and in case of accident repairs may be made "on the field" by moving forward the rear stud as one bolt or stud will still provide working strength for the tool.



The application of jaws to handle remains the same superior, perfect fitting, milled construction as has for so many years proved entirely satisfactory in the Vulcan wrenches. A full line of the "Vulcan-Bijaw" wrenches in sizes for ⅛ to 12 in. pipe and fittings and with interchangeable cable or flat link chains will be ready for the

market April 1st, 1910. Catalog will be sent free to any one desiring it.

PRESENT TENDENCY TOWARD the generation of steam in large units is being exemplified by the Detroit Edison Co., who have just purchased 4 13-retort Taylor stokers to be used with 2 2300 hp. Stirling boilers. This great output from a single boiler is secured by double firing with a stoker at each end, each boiler having a furnace 26 ft. by 15 ft. The Taylor stoker was selected because of its great overload capacity. So far as known by the American Ship Windlass Co., manufacturers of the Taylor, these are the largest stokers in the world.

THE PEERLESS RUBBER MFG. CO., of 16 Warren St., New York, have recently opened a branch office at 704 Arch street, Philadelphia, Pa. The Goodall Rubber Co., Inc., have been appointed its distributors for Philadelphia and vicinity, and will carry a large stock to meet demands for the Peerless line of rubber goods.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rate of 40 cents per line. About nine words make a line. No display type is allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 15th of month preceding publication.

Positions Wanted

POSITION WANTED—Superintendent of machine work manufacturing steam, power and refrigerating machinery. Address Box 125, Practical Engineer. 2-2

POSITION WANTED—By practical engineer in manufacturing or small power plant. Good reasons for desiring a change. References. Address Box 127 Practical Engineer. 3-1

POSITION WANTED—As assistant engineer. Seven years' experience, also nearly completed course in I. C. S. Can furnish good references. Address F. F. Ninman, Belle Plaine, Wis. 3-1

POSITION WANTED by gas engineer, familiar with large engines, also steam turbines and electricity. At present erecting engineer, but desires to make a change. West preferred. Box 129 Practical Engineer. 3-1

POSITION WANTED—As engineer and fireman in small power plant or assistant in large one. Have Minnesota license and I. C. S. education. Age 26; sober and reliable. Address M. Peterson, Hutchinson, Minn. 3-1

Help Wanted

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 15 of this issue. 9-tf

AGENTS WANTED—West of Buffalo and Pittsburg to sell a necessary power plant specialty that is a big money maker. We allow a liberal commission. Address, stating experience, Box 126 Practical Engineer. 3-tf

WESTERN POSITIONS—For seven years have furnished prominent Western mining, railroad, irrigation, contracting companies with engineering employees. If you wish to come West, write us. Business Men's clearing House, Dept. EE, Century Bldg., Denver. 3-1

SALESMEN—Competent to represent manufacturers of a high grade steam specialty of which a large number have been sold, with plenty of testimonials to back them, will do well to reply to this. Only those having experience selling steam specialties will be considered. Orders taken on 30 days' trial. Liberal commission and exclusive territory. Address Box 128 Practical Engineer. 3-1

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-tf

AGENTS WANTED to represent us in the sale of Cassco Bar and Ring Metallic Packing—a metallic packing which costs about the same as soft packing and will wear from seven to ten years. Can be handled as a side line very acceptably. Some territory still open for steam specialty men to handle the Erwood Positive Duplex Blow-off Valve and the Erwood Reversing Automatic Non-Return Valve. Address Triumph Engineering & Supply Co., 253 La Salle Street, Chicago, Ill. tf

For Sale

FOR SALE—60 steel storage tanks, 6,000 gallons' capacity. Good as new. Double riveted, extra well built. Suitable for storage of oils, waters or liquids of any kind. 100 steam pumps. Get our prices on engines, boilers and electrical machinery. All sizes and kinds. Chicago House Wrecking Co., 35th and Iron Sts., Chicago.

Machinery For Sale

FOR SALE—ENGINES AND BOILERS—Corliss—Heavy Duty, 18 x 36 Ohio, 24 x 30 Clark, 22 x 48 Allis. Girder Frame, 14 x 30 Bass, 18 x 42 Allis, 22 x 42 Hamilton, 28 x 54 Hamilton. Automatic—All sizes, 30 to 400 hp. Send for list. Throttling engines from 10 to 100 hp. Woodworking machinery of all kinds. Cleveland Belting & Machinery Co., 1922 Scranton road, Cleveland, Ohio. 9-tf

Patents and Patent Attorneys

PATENTS—EUGENE C. BROWN, engineer and patent lawyer. Nine years examiner in electrical and mechanical divisions, U. S. Patent Office; member Bar U. S. Supreme Court. Send sketch for advice. Victor Bldg., Washington, D. C.

PATENTS—Watson E. Coleman, Patent Attorney, Washington, D. C. Advice and books free. Highest references. Best services. 4-tf

PATENTS OBTAINED AND TRADEMARKS Registered—Our booklet, "Concerning Patents," mailed free. Calver & Calver, Patent Attorneys, Washington, D. C. (Formerly Examiners, U. S. Patent Office.) 3-2

HAVE YOU AN IDEA? If so write for our books: "Why Patents Pay," "100 Mechanical Movements" and a Treatise on Perpetual Motion—50 Illustrations. All mailed free. F. Dieterich & Co., Patent Lawyers and Experts, Oray Block, Washington, D. C. 1-tf

PATENTS—For a Canadian or foreign patent send sketch for free report. Patentability certificate given. Canadian patents taken up for sale if desired. Send ten cents for booklet and inventors' monthly magazine. Ben. B. Pannett, Ottawa, Ontario, near Patent Office. 9-tf

PATENTS—C. L. Parker, late Examiner U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Hankbook for inventors sent upon request. 186 McGill Building, Washington, D. C. 4-tf

Educational and Instruction

MECHANICAL DRAWING—Ten lessons one dollar. Additional lessons ten cents. Lucien Jones, 115 South 54th Street, Philadelphia. 3-2

Miscellaneous

ANY FORMULA or recipe you want, 10c; 3,000 for 40c. Satisfaction guaranteed. A. R. Weissgerber, 3451 N. Hamilton, Chicago. 3-1

SAVE MONEY—RENEW Old Dry Batteries—Make good as new at very little cost. Full correct instructions only 25c; regular price $1.00. Northern Supply Co., Battery Dept. 4, 3451 N. Hamilton, Chicago. 2-1

FREE, ANY FIRM owning a steam plant, or any engineer in charge of steam plant, that is troubled with scale and has to use boiler compound can get the best indicator and reducing wheel made free. Address Great Lakes Chemical Co., Manitowoc, Wis. 10-tf